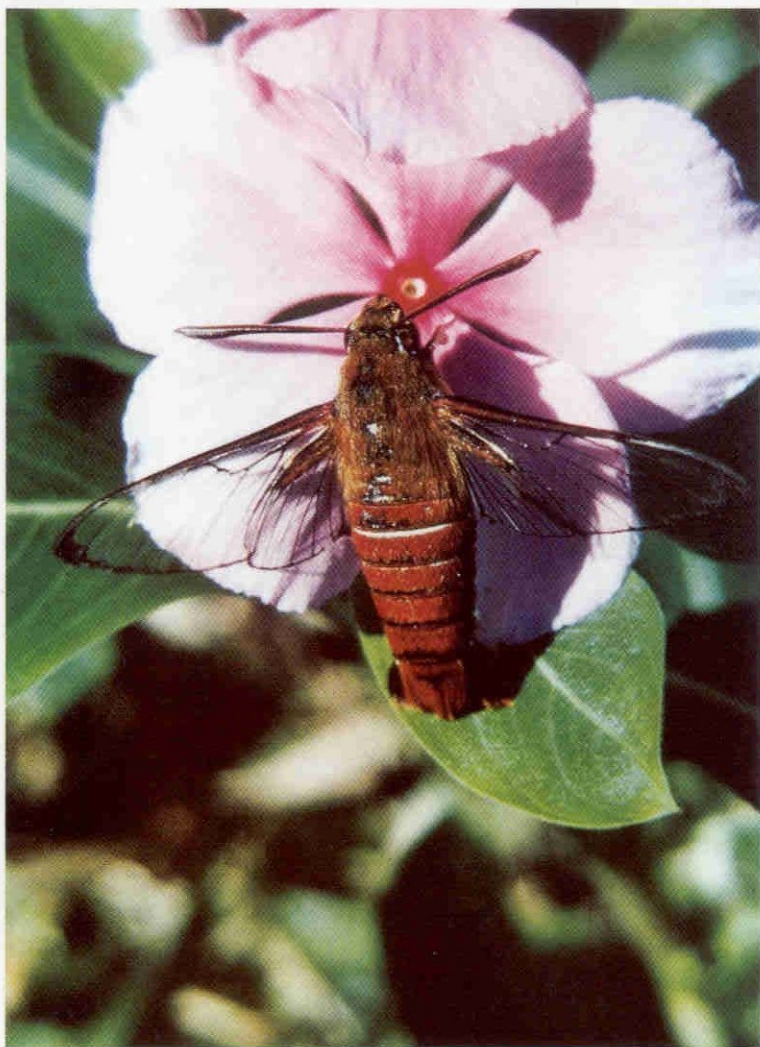


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EDITORIAL

No reference to the last year can be made without a comment on the weather; almost unbelievable deluges hit the region with few areas unaffected. The effects of this on the fauna and flora of the islands are difficult to evaluate. The few species that are studied on a continuous basis seem to have been surprisingly unaffected. Surveys of invertebrates are continuing to yield new records and indicate a significant change in composition in at least some areas. It is far too early to say that this has anything to do with the rainfall but it is difficult to avoid the temptation of saying that the weather is behind such rapid change. Certainly plants are responding to the record levels of rain with many hygrophilic species rapidly extending their ranges. So far this seems to be favouring many of the rare endemic species, although it may also encourage relatively obscure alien species to develop invasive tendencies.

How long we expect these conditions to persist depends on what we believe to be the cause. For some time dramatic weather changes have been predicted as a consequence of global warming, but most people have been eager to leap upon the 1997 El Niño as the cause of everything from flood to drought. The truth of the matter probably lies in a combination of the two. Whilst El Niño is probably the proximate cause of the flooding of the western Indian Ocean its effects seem to be felt more often, earlier in the year, in more places and with a greater severity than in even the recent past. Many believe that global warming lies behind this. If this is so we can expect similar events to recur uncomfortably frequently. These factors combine with our own regional weather systems in ways that cannot be understood at present. All we can do is to take our example from the natural world - make the most of the abundant water but be prepared for either continued flooding or a sudden switch to drought.

The wet weather is a splendid opportunity for habitat restoration and for research (except in areas actually under flood water!), but not everything is likely to benefit. With apparent changes in current patterns and associated exceptionally high sea temperatures and high tides coastal erosion is dramatic, as is coral bleaching and it is likely that the 1997 disaster for the tern colonies will be repeated this year. Whatever happens, these are times of dramatic change, challenging researchers and managers alike, highlighting the shortcomings in our knowledge and existing programmes, but also providing remarkable opportunities.

J. Gerlach
Editor

CHAIRMAN'S REPORT

The establishment of a permanent office for The Nature Protection Trust of Seychelles on Silhouette island last year enabled us to initiate three conservation projects that we had been planning for some time. The Silhouette Conservation Project aims to carry out research and planning for all conservation issues on the island. Major support from the Islands Development Company in the form of rent free accommodation and office space and the use of land adjacent to the NPTS quarters have made this project a reality. The Seychelles Giant Tortoise Conservation Project became feasible once the land was made available to construct enclosures for this project and for the Seychelles terrapin conservation project. These latter projects are essentially captive breeding programmes for the species involved.

The move to Silhouette brought with it the realisation that not all NPTS projects should be the total responsibility of the Chairman. The council which had been waiting in the wings in the past, was revitalised at the extraordinary general meeting in January 1998. The council now meets quarterly and reviews the reports on the current projects prior to presentation to the Conservation Division of the Ministry of Environment. Members of the council have taken on the responsibility of the management of the Roche Caiman Bird Sanctuary thus relieving the Chairman and Secretary from this task.

Fund-raising for the NPTS and its various projects have been left once again in the hands of the Chairman and Secretary. Overseas funding for the Seychelles Giant Tortoise Conservation Project was raised entirely by Justin Gerlach. Money for the purchase of all ten tortoises was raised through his tortoise adoption appeal publicised on the BBC's Natural History Programme.

Support from various organisations and individuals has been essential and we wish to thank the following donors for their valued assistance:

I.D.C. - for the premises and logistic support on Silhouette

Rick Watson - donation

Robert Levenson - donation and fund-raising assistance

Special Expeditions - matching funds raised on MV "Caledonian Star"

David Cabello - sale of fund-raising items on SY "Panorama"

Amalgamated Tobacco Ltd - sponsor membership

Cousine island Co. - sponsorship for terrapin project

Seychelles Breweries (Guinness Water for Life initiative) - Mare aux Cochons surveys

Air Seychelles - reduced air fares

BODCO - donation

Pool & Patel - for acting as our honorary auditors

British Chelonia Group - sponsorship for tortoise and terrapin projects

Fauna & Flora International - for fund-handling assistance

Dr. J. Steinbacher and Gefiederte Welt - for donations and moral support.

CHAIRMAN'S REPORT

We would also like to thank a host of equally important donors who have made smaller but significant donations and those kind people who have given us moral support and encouragement during the year.

Support for the projects on Silhouette also came from our first two conservation volunteers who financed their trips to Seychelles personally. Thomas Lambert who spent nine weeks on Silhouette with a short break on Aride island, helped with various monitoring programmes. Georgina Kynaston, "tortoise person", spent five weeks being responsible for our ten giant tortoises and the terrapins.

In January 1998 the NPTS acted as the national coordinator for the Wetlands International African Waterfowl Census. The census is carried out in January and July of each year at various selected sites in each participating country. The results of the census are published in an annual report produced and distributed by Wetlands International.

Under the patronage of Sir David Attenborough, the Seychelles giant Tortoise Conservation Project continues to attract a great deal of attention outside Seychelles. Interest in the project from Jon Chaston, reptile curator at Blackpool Zoo in England led to the identification of a male *Dipsochelys hololissa* in the zoo's collection. This tortoise, named Darwin, was at the centre of a burst of media attention which publicised the project and a wider search for more specimens.

Terrapins of both species were acquired from Mahé for the Seychelles Terrapin Conservation Project. These animals are housed in separate enclosures with plastic lined ponds. The experience gained over the past nine months has led to a radical redesign of the ponds and we hope to reconstruct these inside a more substantial enclosure this year. The aim of the project is to captive breed the terrapins in the hope that secure habitats will be established for them on Mahé, Praslin and La Digue.

Conservation projects directly related to the Silhouette Conservation Project were carried out in the high-altitude marsh area of Mare aux Cochons. Surveys funded by Seychelles Breweries through the "Guinness - Water for Life" initiative were undertaken in preparation for the planned restoration of the marsh.

The Roche Caiman Bird Sanctuary remains an important area for waterbirds, especially in view of the changes that will result from the development on the inter-island quay mudflats. The rainfall over the last 18 months has made vegetation management a problem. We still intend opening up an area of permanent water between the hides which will improve the prospect for birdwatchers.

With increased involvement in these projects by the council members and increasing membership, the NPTS will continue to flourish and play its role in conservation in Seychelles as a wholly Seychellois conservation body dedicated to the protection of our biodiversity.

R. Gerlach
Chairman

NPTS SCIENTIFIC COMMITTEE

With a number of NPTS projects planned over the last few years becoming active management projects there has been little new work for the Scientific Committee. No new research or management projects were proposed during 1997. The start of active research and management for the Silhouette Conservation Project prompted some further discussion of monitoring programmes (such as monitoring of the sheath-tailed bat, *Coleura seychellensis*) which had been considered previously.

NPTS Scientific Committee

FREGATE ISLAND INVERTEBRATES

Report on captive-breeding of Fregate Island invertebrates

I am pleased to report that since my last update both the Fregate beetles (*Pulposipes herculeanus* Solier, 1848) and the giant millipede (*Seychelleptus seychellarum* (Desjardins, 1834)) groups are continuing to do well with large numbers of young being recorded. To date we have had 6 new adults emerge and for the most part we have not observed any size reduction in these F1 individuals. Also the majority of our wild collected adults are still alive some two years after arrival at the Zoo. We have colour coded the different beetle generations so as to be able to determine actual longevities for the species in the captive situation.

Our many young millipedes are between the 4-7cm length range and can be seen feeding on a range of fruit and leaf litter material.

The enid snail (*Pachnodus fregatensis* Van Mol & Coppo, 1980) situation has been rather more of a roller coaster situation. By this I mean that our initial stocks did so badly at the Zoo that we decided to split the groups with two other collections. The animals that went to Jackie Pedley (a keen snail keeper) did tremendously well with large numbers of young successfully growing to adult. Unfortunately, we have since heard that this group fizzled out with a suggested cause being possible heat stress last summer. At London Zoo we were successful in rearing one hatched snail through to adult which very interestingly went on to produce a single baby which is growing nicely. This birth is clear proof that this species can self fertilize. The notable success of Jackie in particular, together with our modest but interesting surviving population encourages us to suggest that a new *ex situ* culture trial would be well worth trying when the opportunity next presents itself.

We are endeavouring to keep as many observations on the Fregate animals as possible and will be procuring a detailed account of progress with all three species in the near future.

Paul Pearce-Kelly, Curator of Invertebrates
Zoological Society of London (icczsl@gn.apc.org)

ROCHE CAIMAN BIRD SANCTUARY 1997

1). Salinity

The Bird Sanctuary was flooded with rain water for most of 1997; no salinity readings were taken.

2). Vegetation

The introduced species *Muntingia calabura* L. is still present in the Bird Sanctuary and 4 mature trees and 1 seedling were located in July 1997.

New plant recorded on 25/7/1997 were:

Senna sophora (L.) Roxb.

Hypoxidia rhizophylla (Baker) Friedm. This is a remarkable record with this endemic species colonising the dense *Casuarina equisetifolia* J.R. & G. Forster litter. The single plant present is the lowest altitude record for this species. It is presumed that the plant colonised as a seed dispersed by a bird. The nearest known population of the plant is on the slopes of Copolia, some 2km to the north-west.

3). Invertebrates

The only new record is the pond snail *Gyraulus mauritianus* (Morelet, 1876) which was present in the permanent water near the hides on 25/7/1997.

4). Vertebrates

Bird records are summarised below (NB. no counts made after May).

Species	J	F	M	A	M	J	J	A	S	O	N	D
Grey plover		1										
Whimbrel	1	1	1	1	2							
Greenshank	2	4	1	3	1							
Wood sandpiper	2	1										
Common sandpiper	1			1								
Curlew sandpiper	12											
Little stint	1											
Grey heron	2	2	4	4								
Green-backed heron	4	3	1	2	3							
Cattle egret	1			3	1							
Little egret	2	1		2	1							
Chinese bittern		1		3								
Black-crowned night heron	12	8		11								
Great white egret	1			1	1	1				1		
Moorhen	2	3	1	3	3							
Spotted crane	1	1										
Snipe sp.	1											

J. & R. Gerlach

NPTS RESEARCH & CONSERVATION PROJECTS

SEYCHELLES GIANT TORTOISE CONSERVATION PROJECT

Following successful fund raising we were able to purchase and exchange all the Seychelles giant tortoises previously identified as being important to a captive breeding programme. We are grateful to all the owners of these animals for their co-operation and assistance and to everyone who adopted a tortoise or made a donation. In July 1997 6 (3 male, 3 female) *Dipsoschelys hololissa* and 2 (1 male, 1 female) *D. arnoldi* were transported to Silhouette by the Islands Development Company. These were housed in two large enclosures at La Passe. The tortoises proved themselves to be very adaptable and appeared undisturbed by their journey. Mating attempts were observed within minutes of arrival and these continue with high frequency and with the females showing a very encouraging degree of co-operation. It is hoped that successful breeding will occur in the near future despite initial expectations that it would take several years for them to settle into their new home.

Later that year another group of *D. arnoldi* was identified and negotiations with the owners were initiated. It was arranged that three females and a male would be purchased from this group to add to our single pair. In October the tortoises were sent to Silhouette but we were surprised to find only two, and both males! It transpired that the females were being retained in the hope that they would breed where they were. As experienced tortoise keepers have described their existing situation on Mahé as "slow death" conditions this is extremely unlikely. We are continuing to try to secure a better future for these extremely important animals.

During 1997 a male 'Aldabran' tortoise at Blackpool Zoo, UK, was brought to our attention as being of interest. We were able to confirm that this animal is *D. hololissa*. Efforts are now being made to locate other Seychelles tortoises outside Seychelles and to establish other breeding groups.

Everyone concerned with the project received a major boost to their morale when Sir David Attenborough agreed to be a patron of the project. We are very grateful for his interest in and support for our work.

SEYCHELLES TERRAPIN CONSERVATION PROJECT

The Seychelles Terrapin Conservation Project became an active conservation project during 1997. As the Seychelles terrapins are legally protected, a proposed captive breeding programme required approval from Ministry of Environment before it could start. This was obtained and efforts were made to collect terrapins from a site ear-marked for development. The initial trapping effort was unsuccessful and the first captive animals were all rescued pets. These comprised 4 (3 female, 1 male) *Pelusios subniger* and 1 (female) *P. castanoides*. A captive male *P. castanoides* and another female *P. subniger* were subsequently donated to the project. In January 1998 3 further *P. castanoides* (2 male, 1 female) were rescued for the development site and added to the captive breeding project.

At this early stage most work on the terrapins is concerned with research into their behaviour and ecology. A considerable amount of valuable information has been collected already and modifications to the enclosures are planned.

NPTS RESEARCH & CONSERVATION PROJECTS

SILHOUETTE CONSERVATION PROJECT

After several years of planning and preparation the Silhouette Conservation Project became an active project in April 1997. The Islands Development Company provided facilities for the project at La Passe. This extremely important conservation initiative has been made possible through the support and highly constructive co-operation of the IDC.

The first year of the project have been spent establishing facilities at La Passe for the Silhouette Conservation Project, Seychelles Giant Tortoise Conservation Project and Seychelles Terrapin Project. Monitoring programmes have been planned and are being implemented. A survey of the abandoned former high-altitude marsh at Mare aux Cochons has been undertaken with the support of Seychelles Breweries (Guinness "Water for Life" initiative). This is the first stage in a plan to restore this degraded site. Since 1990 we have been carrying out surveys and research on Silhouette, these researches have been continued and continue to yield exciting and surprising results. Some of the latest finds are described elsewhere in this issue of *Phelsuma*. Whilst not immediately part of the conservation project this research is an invaluable part of the project's development.

J. Gerlach

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[S = granitic islands, Bird & Denis; Ami = Amirantes; Ald = Aldabra]

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Seychelles Geology and the Shiva Impact Crater Theory

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SEYCHELLES

Introduction

In 1980 an article appeared in the scientific magazine *Science* postulating that the sudden extinction of the dinosaurs was caused by the catastrophic impact of an asteroid or comet with planet Earth some 65 million years (Ma) ago (Alvarez et al. 1980). Indeed, not only the dinosaurs, but nearly half of all genera and over three-quarters of all species became extinct at that time (Rampino et al. 1997), a time when environmental conditions changed so dramatically across the entire planet that one geological era, the Mesozoic, ended and a new one, the Tertiary, began. The boundary separating these two eras is known as the Cretaceous-Tertiary Boundary, or KTB, and the impact presumed to have brought about these global environmental changes is known as the *KTB impact*.

Because of the great fascination people have with dinosaurs, not only amongst the general public but also within the scientific community, and because of the exotic nature of this presumed mechanism of their extinction, the impact theory received a wide audience and the search began amongst scientists to locate the actual site of the KTB impact. During the 1980s several sites were put forward as candidates for the title of "KTB Impact Crater", but none received wide acceptance for a variety of reasons - being either too old, or not old enough; too small, or not formed by an impact after all.

One of these postulated sites was the roughly circular, ~300km diameter Amirante Basin that lies immediately south of the granitic Seychelles islands (Fig. 1). This basin is partially ringed by the arcuate Amirante Ridge which was interpreted to be part of the impact crater rim (Hartnady 1986). Alt et al. (1988) agreed with this idea, but enlarged the crater to ~1000km diameter to place the granitic Seychelles islands at the centre of the presumed impact and include a portion of the Deccan Plateau of western India. On geological grounds, however, Damuth and Johnson (1989) rejected the

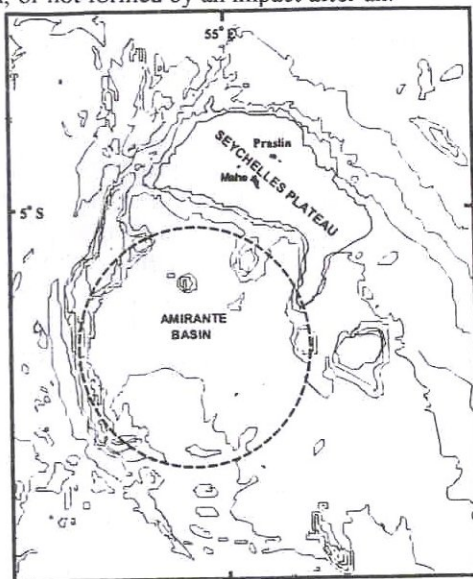


Fig. 1 Amirante Basin and Ridge with respect to the Seychelles Plateau and granitic islands. Dashed circle is a postulated crater outline 360km diameter, similar to that of Hartnady (1986).

postulate of the Amirante Basin being of impact origin at all, let alone being the KTB impact crater, because of the lack of any evidence of disruption within the pre-existing rocks that such an earth-shattering impact would cause.

Periodically during the 1990s, however, the impact origin for the Amirante Basin and its marginal Ridge has been revived (Chatterjee 1992; Chatterjee & Rudra 1996) and even reported in *Time* magazine (Spaeth 1996). These authors believe the Amirante area of Seychelles forms the lower half of a teardrop-shaped

crater that incorporates the Bombay High area of offshore west India (Fig. 2), a crater they have christened the Shiva Crater. Yet if this Shiva Crater was formed by the impact of a single asteroid or comet, how could it be split into two with the halves separated by some 3000km of ocean? To answer that question we must briefly look at the geological history of Seychelles and its palaeogeographical position at 65Ma, the time of the KTB impact.

Geological Setting of Seychelles at 65 Ma

Being granitic in composition, the Mahe-Praslin group of mid-oceanic Seychelles islands are continental in nature. In this they are unique, for all other truly mid-oceanic islands are of volcanic origin. The granitic Seychelles islands are in fact exposures of a submerged, elongate microcontinent that lies amid the western Indian Ocean. Before 160Ma, however, the Indian Ocean did not exist and the Seychelles microcontinent was sandwiched between north-eastern Madagascar and western India within a supercontinent called Gondwana (Fig. 3a). At about 160Ma Gondwana split into two and Madagascar-Seychelles-India lay along one margin of East Gondwana (Fig. 3b). Gradually East Gondwana then disintegrated, with Antarctica-Australia carving off at ~120Ma and Seychelles-India leaving Madagascar at ~85Ma. By 65Ma the Seychelles microcontinent had reached its present position with respect to Madagascar, although it was still attached to India (Fig. 3c). It was at this time that the KTB impact occurred (65.5 ± 3.0 Ma according to Krogh et al. 1993), the centre of which Chatterjee and Rudra (1996) placed in the Seychelles-Bombay High area (Fig. 4). It is only since that time that India rifted from Seychelles and drifted north to collide with Asia. It should be possible, then, by looking at the characteristics of the rocks of Seychelles, to prove or deny the existence of the Shiva Crater, for impacts of extraterrestrial objects leave distinctive geological signatures.

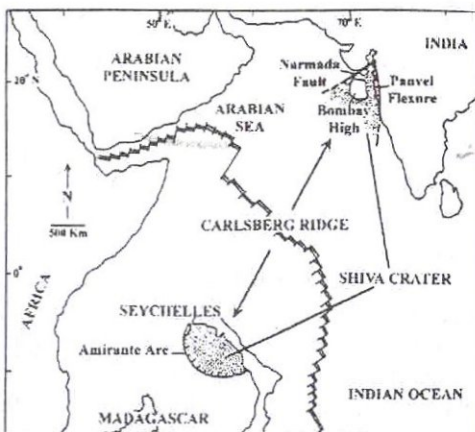


Fig. 2. Present-day location of the postulated Shiva Crater within the Indian Ocean according to Chatterjee & Rudra (1996).

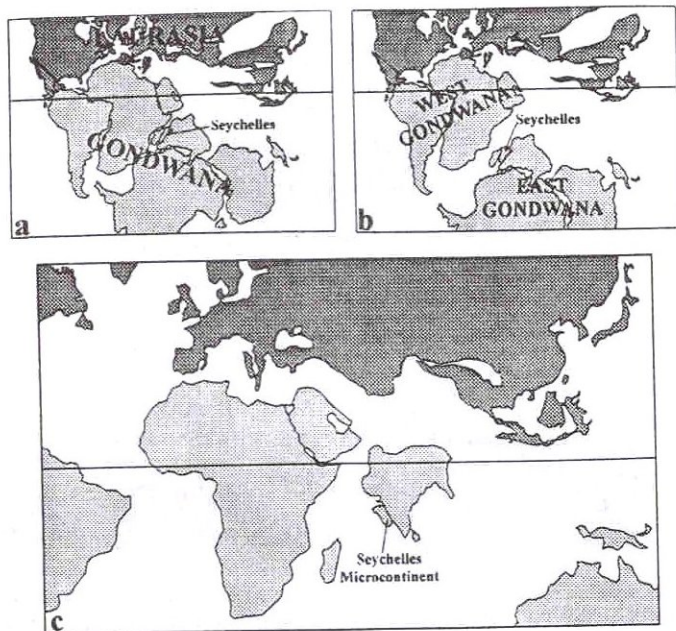


Fig. 3. Palaeogeographic configurations showing the breakup of Gondwana: (a) the supercontinent before 160 Ma, (b) East and West Gondwana at ~125Ma and (c) Seychelles - India amid dispersed Gondwana at ~65Ma.

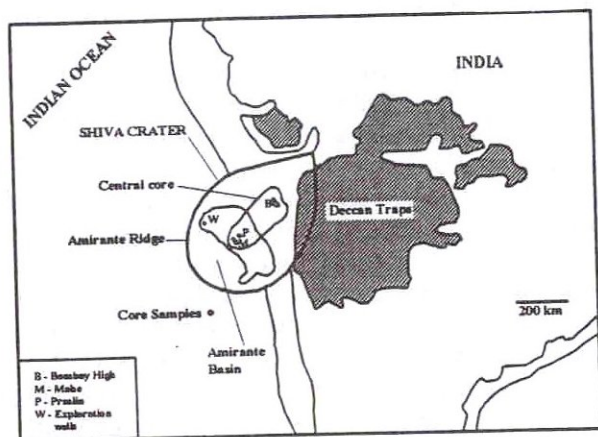


Fig. 4. Palaeogeographic reconstruction of continental Seychelles against western India at 65Ma showing outline of the postulated Shiva Crater, according to Chatterjee & Rudra (1996).

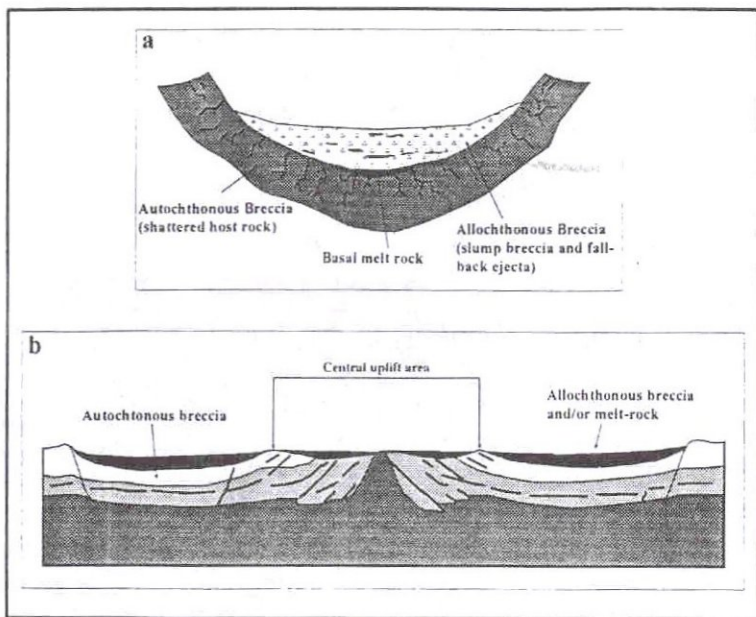


Fig. 5. Representative cross-sections through impact craters, (a) simple (≤ 4 km diameter), (b) complex (> 4 km diameter), after Grieve (1997).

The Geology of Impact Structures

Impact craters on any planet display a progression in morphology from simple bowl-shaped depressions with raised rims, where diameters are less than ~ 4 km (Fig. 5a), to complex structures typified by a raised central core of older uplifted rocks amid a flat annular trough and surrounding raised rim that is structurally complex and faulted (Fig. 5b; see Grieve 1997, Sharpton & Marin 1997). Beyond diameters of ~ 150 km, impact craters no longer display single rims and single raised cores, but rather multiple rims and cores composed of clusters of peaks that are themselves arranged into rings (Alexopoulos & McKinnon 1994, Sharpton & Marin 1997).

Surrounding any crater, of simple or complex form, is a blanket of sediment ejected from the crater. Within the crater itself a layer of "allochthonous breccia", sediment slumped from the crater rim or ejecta that has fallen back into the crater, overlies an "autochthonous breccia", composed of the shattered host or target rocks that are still *in situ*. Between these breccias can occur a melt-rock, formed during the impact by the very high temperatures and pressures induced in the surface layer of the target rock. If the impact is of sufficient intensity this melt-rock can be of significant quantity and can flow out over the crater floor. Within the various breccia and ejecta deposits, component particles often display evidence of shock metamorphism, such as closely spaced shock lamellae in quartz grains, or the inclusion of high pressure metamorphic minerals such as the polymorphic quartz phase known as stishovite. Finally, within the rebounded core of large impact craters, the older uplifted rocks are generally shattered and display diagnostic shock-induced features called shatter cones or cone-in-cone structures.

Seychelles Geology & the Shiva Crater

If the massive KTB impact occurred in the area of Seychelles 65.5 million years ago, then several lines of supportive evidence should be readily apparent, including a shattered uplifted core, breccias and/or melt-rocks within the crater, a rim of upturned sediments or igneous/melt-rocks datable to 65.5Ma, and/or diagnostic high pressure minerals and structures.

The Crater Rim

The principal line of evidence used by Hartnady (1986), Chatterjee (1992) and Chatterjee & Rudra (1996) for concluding that the Shiva Crater exists, at least in part, in Seychelles is the subcircular shape of the Amirante Ridge and its enclosed basin. The Amirante Ridge, however, is not the smooth, extensive curve depicted on the sketches of the crater provided by these authors (eg. Fig. 4), but rather an amalgamation of several arcuate segments that are restricted to the western margin of the Amirante Basin (Fig. 6). The ridge is composed of tholeiitic basalt (Fisher et al. 1968 Lelikov et al. 1991), which is a primary magma derived directly from the mantle and not one mixed with impact-melted sediment as would have been expected.

Also, a sample dredged from between 2500 and 3000m depth on the western flank of the ridge (site A128 on Fig. 6) was radiometrically dated to 82 ± 16 Ma (Fisher et al. 1968) which, using today's accepted radiogenic decay constants, translates to ~ 84 Ma (Harland et al. 1982). This links the formation of the basaltic Amirante Ridge with the separation of Seychelles-India from Madagascar at ~ 85 Ma (Plummer 1996) and indicates that it had existed for nearly 20 million years prior to the occurrence of the KTB impact.

Despite this age discrepancy, a newspaper report claimed that soil samples from the Amirante Ridge contained grains of impact-shocked quartz (Prasad 1991 citing Chatterjee). This report is hardly credible, however, for such soil cannot have been sampled from the small coral atolls or sand cays that locally cap the Amirante Ridge. Being isolated mid-oceanic islands their substrates are autochthonous limestone, and it is from these limestones that their sandy covers are derived, later to be cemented by guano. As such, no soil sampled from these islands can be older than Quaternary age (ie. no older than 2Ma) and it is therefore inconceivable for any such soil to contain shocked quartz derived from the KTB impact at 65.5Ma. Just as these reported soils cannot have been

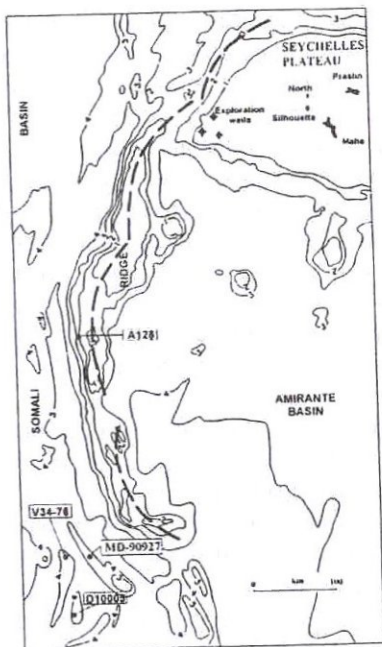


Fig. 6. Detailed bathymetry map (in km) of the Amirante Ridge showing the component arcuate segments, after Plummer (1996). Sample and well locations shown.

sampled from the atolls or cays, neither could they have been sampled from the submerged portions of the ridge. Apart from Quaternary limestones, cores and dredge samples obtained from the submerged ridge have revealed only sediments that were derived directly from the underlying basaltic rocks. The component mineralogy of these sediments (including chlorite, epidote, serpentinite, smectite and zeolites) indicates their formation to have been under conditions of low temperature and low pressure, not the high temperatures and high pressures that result from impacts and that would have been required to produce the reported shocked quartz.

Beyond the presumed crater rim, just to the south of the Amirante Ridge (sites D10005, MD-90927 and V34-76 on Fig. 6), sediment samples were recovered that proved to be undisturbed pelagic nannofossil oozes and chalks. Although Bassias et al. (1993) reported the presence of a blocky layer within the undisturbed pelagic ooze of sample MD-90927, the component argillite blocks were indurated and bore Fe/Mn coatings diagnostic of subaerial weathering. This layer thus formed as a slump of talus and not as impact breccia or ejecta. None of the other core samples contained evidence of included ejecta material, but they did contain a wealth of delicate microfossils (foraminifera, coccoliths and dinoflagellates) that were diagnostic of pre-Maastrichtian Late Cretaceous deposition at ~73Ma (Johnson et al. 1982, Masson et al. 1982). It was the generally undisturbed nature of these pre-KTB sediments that Damuth and Johnson (1989) cited to refute Hartnady's original postulate of the impact origin of the Amirante Basin and Ridge, for in such close proximity to such an earth-shattering event it is inconceivable that these sediments would remain undisturbed. Thus both the sediments adjacent to the Amirante Ridge and the ridge itself existed well before the KTB impact and neither were formed as a result of the impact event.

Within the Crater

If the "roughly circular" Amirante Basin was in fact the KTB impact crater, then the rocks within the basin that are older than 65.5Ma would be totally disrupted and brecciated and should contain evidence of melt-rock. Fortunately, in 1980/81 Amoco drilled three deep exploration wells at the westernmost extremity of the Seychelles Plateau, which lies just inside the arcuate Amirante Ridge, the presumed crater rim (see Fig. 6). The deepest penetration by these wells extended some 2700m beneath the level of the KTB, yet the sediments encountered showed no evidence of disruption or brecciation, nor of any high pressure, or shock, metamorphism. In fact, the sedimentary rocks encountered were well layered and correlatable between the wells (Kamen-Kaye 1985, Plummer and Belle 1995) and although volcanics were interbedded, they proved to be tholeiitic lavas dated at between 71 and 78Ma that originated during the later development of the Amirante Ridge (Plummer 1996) and not from the impact-induced melting of a sedimentary target rock at 65.5Ma.

Chatterjee and Rudra (1996) postulated that a series of alkaline igneous complexes that occur within the presumed crater and beyond its rim on the Indian side were formed by crystallization from melted country rock. Two of these alkaline igneous complexes in fact lie within the Seychelles portion of the presumed crater at Silhouette

and North islands. Several samples from these complexes have been dated by the Rb/Sr radiometric method (Dickin et al. 1986), including microgranite, syenite, tuff (Silhouette), diorite, gabbro and syenite (North). The resultant ages are very consistent, with Silhouette having formed at 63.2 ± 1.0 Ma while North formed at 63.0 ± 3.1 Ma. Yanagi et al. (1983), also using the Rb/Sr method, dated a diorite from North Island at 60 ± 4 Ma, which lies within error of the Dickin et al. values. Also, the Sr and Nd isotope geochemistry indicates that the parent magmas of these complexes were derived from a primary mantle source uncontaminated by continental crust (Dickin et al. 1986, see Stephens 1996). Clearly these alkaline igneous complexes at Silhouette and North islands not only post-date the KTB impact by ~ 2 Ma, but also, by their lack of continental contamination, reveal no evidence of having been derived from impact-melted country rock.

Other postulated volcanic centres within the presumed crater area of Seychelles are indicated by high Bouguer gravity readings, such as over Constant and Fortune Banks. Computer modelling of the gravity data, however, has revealed these banks to comprise pods of volcanic rocks within thick sedimentary sequences (Joseph 1995), rather than the massive volcanic cones that Chatterjee and Rudra (1996) describe as being 15 km high and dwarfing even Mount Everest. Also, recent drilling on Constant Bank sampled these volcanics and dated them at ~ 60 Ma, significantly younger than the KTB event. Thus, no characteristics of any of the younger igneous rocks of Seychelles relate to the KTB impact or melted country rock derived therefrom.

The Rebounded Core

To form a crater that is 300 to 1000 km in diameter requires an extremely large impact. As such, a rebounded core, or a ring of such cores, of older uplifted target rock should be present. The outcrops of Late Precambrian granite that form the central Seychelles islands were concluded by Chatterjee and Rudra (1996) to represent the uplifted core in the Seychelles half of the Shiva Crater. The Seychelles granites, however, despite several detailed studies (Baker 1963, 1967; Suwa et al. 1983, 1994; Stephens et al. 1995, 1997), have never revealed any evidence of the shattering or brecciation, nor the presence of shock metamorphic minerals (stishovite) or structures (cone-in-cone or shock lamellae), that would have been inevitable from such a massive impact. Although the Seychelles granites have locally weathered into corestones, due to the tropical climate (see Thomas 1994), and these corestones have in places tumbled down slopes to form boulder fields, these surface agglomerations of gigantic granitic boulders are not the result of large scale impact shattering that Chatterjee & Rudra (1996) suggest. In fact, where unweathered beneath the surface layer, the Seychelles granites are quite remarkable for their massive and non-foliated appearance (Suwa et al. 1994), an appearance that bespeaks of a relatively undisturbed history and not one interrupted by a massive impact at 65.5 Ma.

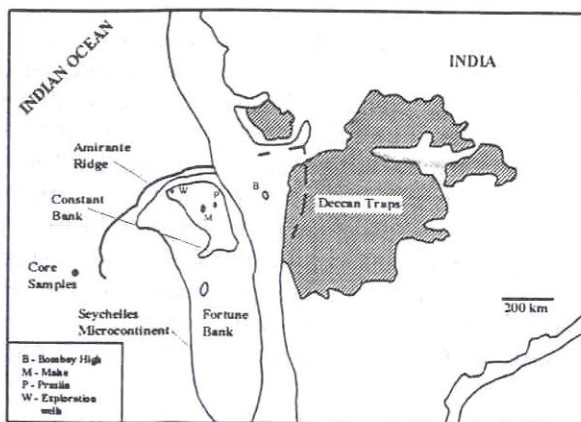


Fig. 7. The postulated Shiva Crater redrawn to honour the outline of the Seychelles microcontinent and bathymetric expression of the Amirante Ridge: clearly a crater no more.

Summary

The postulate that the Amirante Basin to the south of the Seychelles Plateau was the site of the KTB impact at 65.5Ma that caused the extinction of the dinosaurs was based initially on the roughly circular shape of the basin, as defined in part by the arcuate Amirante Ridge. Later, once the crater had been enlarged to include a part of western India, the extent and position of continental Seychelles against the Indian west coast became an important consideration. Unfortunately, and erroneously, only the shallow water Seychelles Plateau was considered to be of a continental nature and hence of significance in that palaeogeographic reconstruction, leading to the postulated crater shown in Figure 4. However, when both the true extent of the microcontinent and the true bathymetric expression of the various morphological features of the presumed crater are considered in greater detail, and when the published geological data are scrutinized and incorporated, the evidence for the very existence of the Shiva Crater evaporates (see Fig. 7), as exemplified by the following points.

1. *The crater rim* - the Amirante Ridge is composed of tholeiitic basalt, not upturned sedimentary rock or melt-rock, and was initiated nearly 20Ma prior to the KTB impact. The Amirante Ridge does not therefore represent the crater rim. Its outline is, in fact, not roughly circular at all, but an amalgamation of several arcuate segments that were restricted in their development within the framework of plate tectonics to the western side of the Amirante Basin.
2. *Within the crater* - the sediments within the Amirante Basin that pre-date the KTB impact show no evidence of brecciation, shock metamorphism, or included melt-rocks. The volcanics interbedded within these sediments either predate the KTB impact

as tholeiitic lavas that relate to the later development of the Amirante Ridge, or post-date the KTB impact as alkaline igneous complexes of mantle-derived lavas.

3. *The rebounded core* - where unaffected by tropical weathering the Seychelles granites are massive and non-foliated, showing no evidence of brecciation or shock metamorphic features such as stishovite, cone-in-cone structures or shock lamellae, as would have been inevitable if depressed by, then rebounded after, a massive impact.

4. *Beyond the crater rim* - the total lack of disturbance and absence of ejecta deposits in sediments just beyond the crater rim is irreconcilable in such close proximity to such a massive impact.

For a geological theory to be valid it must incorporate all the available data. As the above points clearly indicate, the Shiva Crater theory is supported by none of the geological data available from Seychelles, leading to the inevitable conclusion that no impact occurred in the Seychelles region at the KTB at 65.5Ma. Globally, however, there is strong evidence that a massive impact did occur at the KTB, but as Sharpton and Marin (1997) show quite convincingly, that impact produced the ~300km diameter Chicxulub crater and basin, which today lies half a world away beneath the northern Yucatan Peninsula and southern Gulf of Mexico and displays a shattered uplifted central core, impact-breccias, melt-rock dated at 65 Ma (Swisher et al. 1992) and an extensive surrounding blanket of ejecta deposits.

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Ochyroceratid spiders of the granitic islands of Seychelles (Araneae, Ochyroceratidae).

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Abstract: Four species of the family Ochyroceratidae are reported from the granitic Seychelles. One is a parthenogenetic pantropical species *Theotima minutissima* (Petrunkевич, 1929) = *Speocera bonaespei* Brignoli, 1980 n. syn. The other three species are described as new and each represents a new genus; *Ouette* n. gen., n. sp., *Roche roche* n. gen., n. sp., and *Eusora muehlenbergi* n. gen., n. sp.

Key words: Ochyroceratidae, taxonomy, Seychelles

Introduction

The family Ochyroceratidae Fage, 1912 consists of minute to small spiders (total length 0.6-3mm). Carapace relatively low, as long as wide or slightly oval and narrowed at the cephalic region. Clypeus large, protruding and slanting downwards. There are six eyes grouped in two rows; four in anterior (= PME's & ALE's; AME's are lost!) and two in posterior row (=PLE's). Chelicerae are free and fairly strong, armed with several denticles in addition to a lamella. Legs delicate and relatively long - very long; the length of the first femur equals with the length of the carapace. Tarsi and metatarsi may have false articulations. At least some species have a tarsal rod on the dorsal surface of the tarsi (Fig. 12). There are three tarsal claws and an onychium. Colulus well developed. Females have no epigyne but their internal secondary genital organs are well developed and often conspicuously complicated. Barros Machado (1964) has presented a good generalized picture of them. A peculiar feature of these organs in Ochyroceratidae is that the copulatory openings of the female are situated at the lateral margins of the epigastric furrow. More often they may be sifted from their original sites e.g. on the dorsal side of the abdomen and then have superficial chitinous copulatory ducts. Sometimes the surroundings of the copulatory openings may look out quite bizarre. The tracheal spiracle is midway between the spinnerets and the genital groove or close to the spinnerets. Eggs are carried by the chelicerae.

Ochyroceratids are found in the tropics living among litter or as troglobionts. They are often dominant species in bamboo leaf litter and some species even live in bamboo internodes (Deeleman-Reinhold 1995). Several species are known to be parthenogenetic. At the present some 100 species and about 10 genera are known. Four species are reported from Seychelles.

All measurements cited below are in millimeters. To illustrate the length of the legs in different species a relative leg length index, RLI, has been calculated according to the following formula: length of tibia/length of carapace.

The material treated below belong to the following collections:
MRAC = Musée Royal de l'Afrique Centrale, Tervuren
MZT = Zoological Museum of Turku University, Turku

Genus *Theotima* Simon, 1893

Theoclia Simon, 1891: 567. - Type species by monotypy *Theoclia radiata* Simon, 1891 from St. Vincent.

Theotima Simon, 1893: 493 (new name for *Theoclia* Simon, 1891 preoccupied by *Theoclia* Pascoe, 1885; Coleoptera).

Diagnosis: As the genus seems to be fairly heterogenic it has not, at the present, been possible to formulate any simple diagnosis for it.

Theotima minutissima (Petrunkévitch, 1929) (Figs. 1-3)

Oonopinus minutissimus Petrunkévitch, 1929: 70, f. 58-60 (female).

Speocera bonaespei Brignoli, 1980: 385, f. 10 (female). n. syn.

Theotima minutissima, Deeleman-Reinhold 1995: 72, f. 201-206 (female, transferred from

Oonopinus = *Simonocera chamorro* Brignoli, 1986).

-, Baert, Lehtinen & Desender 1997: 16 (transferred from *Oonopinus*).

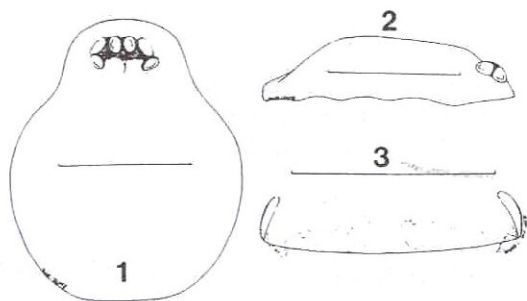
Diagnosis: The female (male unknown) of this species is distinguished by the weakly sclerotized, anteromedially pointing arch at the lateral margins of the epigastric furrow.

Male: Unknown.

Female: Total length ca. 0.96. Carapace 0.47 long, 0.37 wide. Carapace dirty white with violetish pattern. Chelicerae pale yellowish. Sternum, labium, and maxillae almost totally suffused with violet. Apical segment of the female palpus darker than others, strongly suffused with violet. Legs dirty white suffused with violet. Eyes relatively large. Chelicerae with lamella and six denticles.

Material examined: Mahé, Bon Espoir, female (paratype of *S. bonaespei*), 22.6.1972, P. L. G. Benoit & J. J. van Mol legend (MRAC 143.240) and Northolme, 2 females (paratypes of *S. bonaespei*), 27.6.1972, P. L. G. Benoit & J. J. van Mol legend (MRAC 143.422).

Discussion: Dumitresco & Georgesco (1983: 113) transferred the male of *Oonopinus minutissima* sensu Bryant (1944: 264) to *Theotima*. This was an error as being a parthenogenetic species *T. minutissima* has no males. Deeleman-Reinhold (1995) also mention that P. T. Lehtinen designated a lectotype female of *Theotima*



Figs. 1-3. *Theotima minutissima* (Petrunkevitch, 1929). Original figure. Scale bars = 0.2mm. 1). Carapace dorsally. 2). Carapace dextrolaterally. 3). Epigastral area ventrally.

minutissima (AMNH, F 4003). However, in the original description (Petrunkevitch 1929) the type was clearly designated. In addition to the type Petrunkevitch (1929) mentions three other females which apparently are the specimens studied by Deeleman-Reinhold (1995).

Distribution: This parthenogenetic species is apparently widely distributed in tropics and now recorded from Porto Rico (terra typica), Panama, Malaysian Borneo (Sabah), Indonesia (W. Sumatra, Java), Thailand (Deeleman-Reinhold 1995) and Rapa Nui (Eastern Islands) (Baert *et al.* 1997). From Seychelles it has been found only on Mahé.

Genus *Ouette*, new genus

Type species: *Ouette ouette* n. sp.

Diagnosis: At the present *Ouette* contains only its type species *Ouette ouette* and is diagnosed by the same characters as that species.

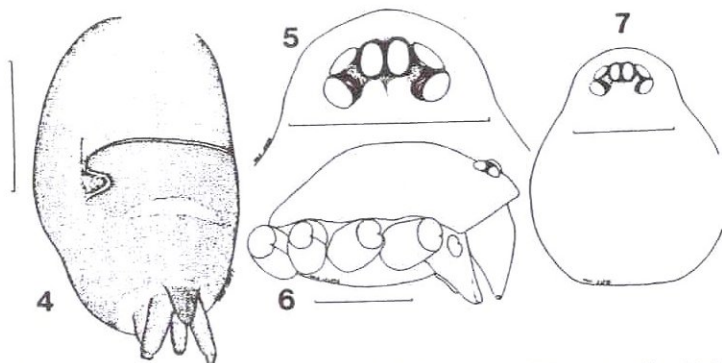
Etymology: Generic name from the type locality: Silhouette.

***Ouette ouette*, new species (Figs. 4-7)**

Type: Female holotype from Seychelles, Silhouette: *Pisonia* forest, leaf litter, 1990, Justin Gerlach legend; deposited in the Zoological Museum, University of Turku (MZT AA 0.074)

Diagnosis: Females (male unknown) of *O. ouette* may be easily recognized by having copulatory openings shifted posteriorly from the epigastric furrow.

Male: Unknown.



Figs. 4-7. *Ouette ouette* n. sp. Original figure. Scale bars = 0.2 mm. 4). Abdomen of female ventrally and slightly aside. 5). Eyes dorsally. 6). Carapace dorsally. 7). Carapace dextrolaterally.

Female: Total length 1.03. Carapace 0.52 long, 0.41 wide. Carapace dirty white with violetish pattern. Chelicerae pale yellowish. Sternum, labium, and maxillae almost totally suffused with violet. Apical segment of the female palpus darker than other segments, strongly suffused with violet. Legs dirty white suffused with violet.

Distribution: Recorded only from Silhouette.

Etymology: The specific name *ouette* denotes that this is the type species of the genus *Ouette*.

Genus *Roche*, new genus

Type species: *Roche roche* n. sp.

Diagnosis: At the present *Roche* contains only its type species *Roche roche* and is diagnosed by the same characters as that species.

Etymology: Generic name from the type locality: Roche Caiman Bird Sanctuary, Mahé.

Roche roche, new species (Figs. 8-12)

Types: Female holotype from Seychelles, Mahé, Roche Caiman Bird Sanctuary, leaf litter, 23.12.1993, Justin Gerlach leg. and four female paratypes with the same data; all deposited in the Zoological Museum, University of Turku (MZT AA 0.301).

Diagnosis: Female (male unknown) of *R. roche* may be recognized by having copulatory openings at the lateral margins of the epigastric furrow superficially marked by narrow, chitinized curves and by the small eyes.

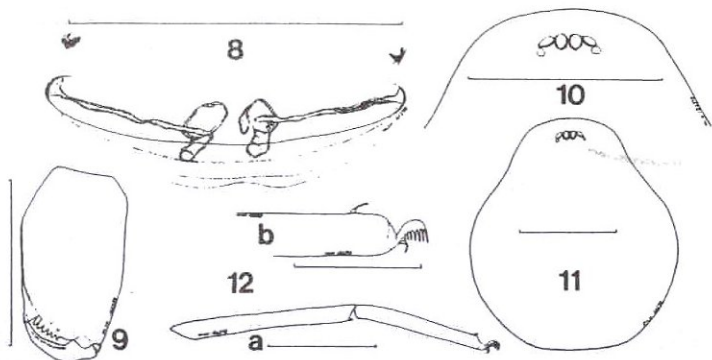


Fig. 8-12. *Roche roche* n. sp. Original figure. Scale bars = 0.2, except for Fig. 9 = 0.1 and for Fig. 12b = 0.05 mm. 8). Vulva ventrally. 9). Left chelicerae anteriorly. 10). Eyes dorsally. 11). Carapace dorsally. 12). Tarsus and metatarsus (a) and tip of tarsus (b).

Description: Total length 1.17. Carapace 0.50 long, 0.40 wide. RLI = 0.69. Prosoma and legs pale whitish; chelicerae yellowish. Abdomen pale grey. Eyes remarkably small. Chelicerae with a lamella and six promarginal and two retromarginal teeth.

Distribution: Recorded only from Mahé, Roche Caiman Bird Sanctuary.

Etymology: The specific name *roche* denotes that this is the type species of the genus *Roche*.

Genus *Eusora*, new genus

Type species: *Eusora muehlenbergi* n. sp.

Diagnosis: At the present *Eusora* contains only its type species *Eusora muehlenbergi* and is diagnosed by the same characters as that species.

Etymology: Generic name is an anagram derived from the type locality: Grande Soeur.

***Eusora muehlenbergi*, new species (Figs. 13-17)**

Types: Male holotype and female allotype from Seychelles, Big Sister (=Grande Soeur), 10.09.1975, M. Mühlenberg legend (MRAC 177.098). Additional paratypes: 2 males, 4 females with the same data as holotype, 1 subad. male, 1 female, Little Sister (=Petite Soeur), 10.09.1975, M. Mühlenberg legend, and 2 males, 2 females, Big Sister (=Grande

Soeur), 17.09.1975, M. Mühlenberg legend (MRAC 177.099 177.115, 177.128, 177.133, 177.145, 177.149, 177.167, 177.171); all deposited in the Musée Royal de l'Afrique Centrale, Tervuren, Belgium.

Diagnosis: Male of *E. muelenbergi* may be easily recognized by having the bulbus partly buried inside the excavation of the swollen tibia and female by having the copulatory openings moved to the sides of the abdomen about level with petiolus.

Male: General appearance as in female. Size somewhat smaller; total length = 0.97. Carapace slightly longer and narrower; 0.50 long, 0.38 wide. Legs slightly longer than those of the female; RLI = 1.00.

No apophysis on the male palp but tibia conspicuously swollen. Bulbus partly lying inside the ventral excavation of the tibia. Bulbus spherical bearing a short, conical embolus and immediately beside it a small, transparent apophysis. When bulbus is viewed anteriorly these two seem to form a wide open V-like figure.

Female: Total length 1.02. Carapace 0.47 long, 0.39 wide. RLI = 0.98. Carapace pale yellowish brown with radiating violetish markings. Chelicerae pale yellowish brown. Sternum, labium, and maxillae somewhat suffused with violetish colour. Apical segment of the female palpus darker than others, lightly suffused with violet. Legs dirty white, sometimes with violetish suffusion. Abdomen pale brown, often strongly mottled with violetish colour. Colulus and spinnerets whitish.

Copulatory openings moved to the sides of the abdomen, about level with petiolus. When the abdomen is viewed ventrally the epigastric furrow and superficial copulatory ducts together seem to form a wide, U-shaped figure.

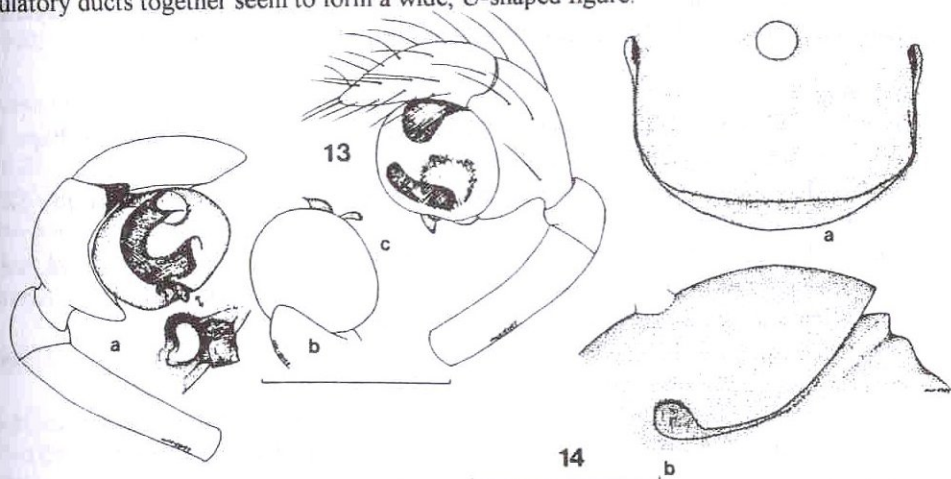


Fig. 13-14. *Eusora muelenbergi* n. sp. Original figure. Scale bars = 0.2 mm. 13). Right male palp laterally (a), anteriorly (b), and mesially (c). 14). Epigastric area of female ventrally (a) and dextrolaterally (b).

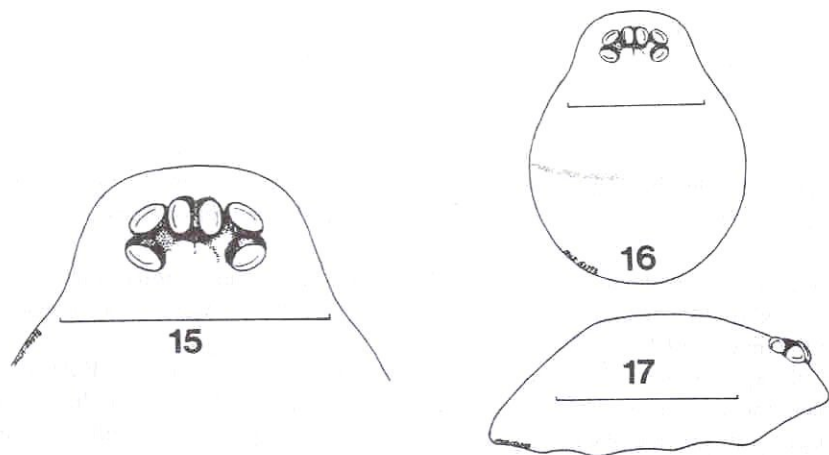


Fig. 15-17. *Eusora muehlenbergi* n. sp. Original figure. Scale bars = 0.2mm. 15). Eyes dorsally. 16). Carapace dorsally. 17). Carapace dextrolaterally.

Distribution: At present the species is known only from Grande Soeur (Big Sister) and Petite Soeur (Little Sister).

Etymology: Named after its collector Prof. M. Mühlenberg.

Acknowledgments:

I am grateful to Dr. R. Joque who kindly arranged the loans of the Seychelles ochyroceratids from the Musée Royal de l'Afrique Centrale, Tervuren.

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Observations on the Odonata of Silhouette, Seychelles Archipelago

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Abstract: 14 species of dragonflies and damselflies have been recorded from Silhouette Island, Seychelles following observations made in 1997, of these two have not been located since 1908. Only one species was confirmed breeding. Of the species expected to be found on Silhouette two could not be located.

Keywords: damselfly, dragonfly, Odonata, Seychelles, Silhouette.

Introduction

Campion (1913) and Blackman & Pinhey (1967) described the Odonata of the Seychelles Islands, including Silhouette, based on their own observations and collections of other entomologists. Two members of the British Dragonfly Society visited Silhouette from 17th to 24th November 1997. The following observations are based on that visit and these records extend the Silhouette species list of Gerlach *et al.* (1997).

Habitat

Silhouette is a granitic island rising steeply from the Seychelles Bank to 740 metres at the summit of Mont Dauban. It has narrow sandy beaches, few areas of coastal plateau, an extensive coral reef and many granitic *glacis* of bare rock. Previous attempts at coconut farming and coffee farming have introduced several alien plant species and the demise of formal agriculture has allowed many former tracks and trails to become minimal or defunct. Mont Pot à Eau and Mont Dauban are relatively inaccessible and have remnants of the surviving rain-forest.

Climate in 1997

1997 was atypical for the Seychelles Archipelago in general and Silhouette in particular. 500mm (20 inches) of rainfall were recorded in four days in August and 75mm (3 inches) in eight hours on 17th November (R. Gerlach pers. comm.). In consequence, all freshwater levels were abnormally high and areas described as *marais* were often water-filled pools with one to two metres of flooded margins, covering terrestrial grasses rather than aquatic rushes and sedges.

Locations

We were able to visit six defined locations in the time available (Fig. 1.). Three localities we did not visit because of adverse tides and inclement weather were Grande Barbe, Mare aux Cochons and Pointe Etienne. The latter two places were locations for previous records (before 1908) of the endemic *Seychellibasis alluaudi* (Martin, 1896), slender damselfly.

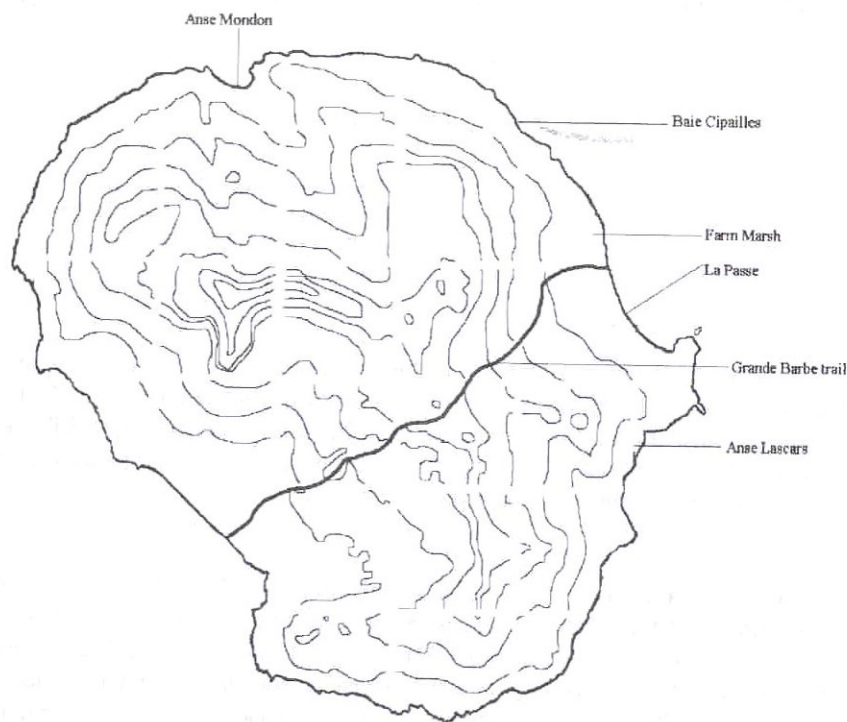


Fig. 1. Location of sites visited on Silhouette island.

The locations are listed in Table 1 in north-ascending order. They are all on the east side of the island and within easy access of the Silhouette Island Lodge.

Methods

Whenever possible, Odonata were caught by sweep-netting for definitive identification based on the key of Blackman & Pinhey (1967). Measurements of the captured insects were recorded for overall and abdominal lengths, total wing-span, hind wing length and size of pterostigmata. Photographs were taken through specimen boxes, hand-held individuals and perching individuals, both after release from the hand and on natural vegetation. If possible, both male and female specimens were caught for examination. Photography was used to record wing-venation and colouring, in addition to general records of colour and size of the insects. Similar methods have been described by Wain *et al.* (1998).

Evidence of breeding was based on combinations of observation of tandem-coupling, of cart-wheel pairs *in cop*, ovipositioning and collection and identification of

exuviae. The suggestion of Prendergast (1997) was followed for presumption of breeding status.

Observations

Species observed are listed in Table 1.

The Seychelles endemic Odonata, *Allolestes maclachlani* Selys, 1869 (black mountain damselfly), *Leptocnemis cyanops* (Selys, 1869) (blue-eyed forest damselfly) and *Zygonyx luctifera* Selys, 1869 (steely skimmer) were all found at low altitudes, less than 100 metres above sea level. *Zyxomma petiolata* Rambur, 1842 (ghost skimmer), a single female was flying along the beach at 15:00 hours.

Discussion

This limited survey of the Odonata of the island of Silhouette has recorded five new species for the island; *Zygonyx luctifera* (steely skimmer), *Zyxomma petiolata* (ghost skimmer), *Pantala flavescens* (Fabricius, 1798) (globe skimmer), *Tholymis tillarga* (Fabricius, 1798) (banded skimmer) and *Anax guttatus* (Burmeister, 1839) (amberwing emperor) (Table 1.).

Table 1. Occurrence of Odonata at different locations on the east side of Silhouette

Species	English name	Anse Lascars	La Passe	Grande Barbe trail	Farm Marsh	Bale Cipailles	Anse Mondon
<i>Allolestes maclachlani</i>	black mountain damselfly			present			
<i>Leptocnemis cyanops</i>	blue-eyed forest damselfly			present			present
<i>Ceragrion glabrum</i>	orange damselfly	present	present	present	present		present
<i>Agriocnemis pygmaea</i>	pygmy firetail	present			present		
<i>Diplacodes trivialis</i>	sky-blue chaser	present	present		present		present
<i>Orthetrum stemmale</i>	striped skimmer	present	present		present		present
<i>Zygonyx luctifera</i>	steely skimmer						present
<i>Zyxomma petiolata</i>	ghost skimmer					present	
<i>Pantala flavescens</i>	globe skimmer	present	present		present		
<i>Anax guttatus</i>	amberwing emperor				present		
<i>Tramea limbata</i>	scarlet chaser		present		present	present	present
<i>Tholymis tillarga</i>	branded skimmer		present		present		

Z. luctifera is an endemic species for the Seychelles archipelago whereas *P. flavescens* and *A. guttatus* are strong fliers and pan-tropical (*P. flavescens*) or from the Asian sub-continent (*A. guttatus*). It is probable that as well as extending the Silhouette species list (Gerlach *et al.* 1997) the list may be revised to eliminate the synonyms (*Allolestes nigra* Martin, 1896 = *A. maclachlani* and *Leptocnemis bilineata* (Selys, 1869) = *L. cyanops*; as defined by Blackman & Pinhey 1967).

In comparison with the Odonata of Mahé (Wain & Wain pers. obs.), the endemic species recorded on this visit were all found at relatively low altitudes. This may reflect the lack of extensive cultivation beyond the coastal margin on Silhouette, since the endemic species usually found above 350 metres on Mahé were often associated with a vegetation transition from invasive coco-plum to endemic forest species. On Silhouette these forest tree species often followed rapid streams right onto the beach, especially at Anse Mondon, where *L. cyanops* was found within 10 metres of the shore-line and *Zygonyx luctifera* males were defending territory less than 200 metres from the beach and well below 50 metres above sea level.

Whilst the single female *Zyxomma petiolata* was patrolling a rocky beach with no fresh water in the immediate vicinity, personal observations in 1997 on Mahé and Praslin have included capture of this crepuscular species over fresh water within 10 to 50 metres of the beach.

Table 2. Presumptive breeding status of Silhouette Odonata.

Species	English name	In tandem	In copula	Oviposition	Exuvia	Breeding
<i>Allolestes maclachlani</i>	black mountain damselfly					possible
<i>Leptocnemis cyanops</i>	blue-eyed forest damselfly	yes				probable
<i>Ceragrion glabrum</i>	orange damselfly	yes				probable
<i>Agriocnemis pygmaea</i>	pygmy firetail					possible
<i>Diplacodes trivialis</i>	sky-blue chaser			yes		probable
<i>Orthetrum stemmale</i>	striped skimmer			yes		probable
<i>Zygonyx luctifera</i>	steely skimmer					possible
<i>Zyxomma petiolata</i>	ghost skimmer					possible
<i>Pantala flavescens</i>	globe skimmer	yes		yes		probable
<i>Anax guttatus</i>	amberwing emperor	yes	yes	yes	yes	confirm
<i>Tramea limbata</i>	scarlet chaser	yes		yes		probable
<i>Tholymis tillagra</i>	branded skimmer			yes		probable

The largest population of *Agriocnemis pygmaea* Selys, 1877 was located at the Farm Marsh and, like the smaller population at Anse Lascars, had different markings from the population seen at Beau Vallon Bay on Mahé in December 1997 (Wain & Wain, pers. obs.). The minimal or absent orange colouring of the final abdominal segment of the male of *A. pygmaea* on Silhouette hindered the identification of this species. The whole of the thorax was covered in a blue pruinescence, unlike those on Mahé in which the thorax was entirely black. These differences warrant further investigation as to the absolute identity of the species.

Surprising omissions from this species list of Odonata are *Ischnura senegalensis* (Rambur, 1842) (African blue-tailed damselfly) and *Rhyothemis semihyalina* (Desjardins, 1832) (brunette chaser). Both of these common African species are present on Mahé (Blackman & Pinhey 1967) and on North Island (Wain et al. 1998) and suitable habitats for these two species were common on Silhouette. They are easily identified and their occurrence on North Island in the same period (Wain et al. 1998) suggests that they may indeed be absent from Silhouette. Further surveys may confirm their surprising absence.

Two species previously recorded from Silhouette (Campion 1913) were not recorded in 1997. We were unable to get to the two sites recorded for *Seychellibasis alluaudi* (slender damselfly) (last recorded in 1908) and we probably did not reach adequate altitudes in the evenings for *Gynacantha stylata* Martin, 1896. There are opportunities for further observations.

Only one species was confirmed as breeding on Silhouette, *Anax guttatus*, with the identification of exuviae as well as observed mating behaviour and ovipositioning. Possible and probable breeding was presumed for all the twelve species recorded in this limited survey (Table 2.) and detailed records from the island from future visits should permit confirmation of all of these species as breeding residents.

Summary

A week of field survey on a limited part of the island of Silhouette has identified five species of Odonata previously unrecorded, extending the species list to 14. All 12 species recorded in this survey showed some evidence of breeding. Opportunities exist for further work on the Odonata of Silhouette.

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The current status of Livingstone's flying fox (*Pteropus livingstonii*) in the Federal Islamic Republic (RFI) of the Comores

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Keywords: *Pteropus livingstonii*, RFI Comores, Critically endangered, IUCN Red List category

Abstract: *Pteropus livingstonii* is an Old World fruit bat (Megachiroptera: Pteropodidae) from the RFI Comores. Recent surveys show a population estimate of around 400 individuals, with natural forest being its preferred habitat. *P. livingstonii* is currently categorized as Critically Endangered (A1c+2cd, B1+2c, C2a) in the IUCN Red List categories for animals. In light of the survey results and the known distribution of this species, it appears that this categorization may be over-cautious. Although more data are desirable, we conclude that Endangered (A1c+2cd, B1+2c, C2a) is presently a more appropriate category for this species.

Introduction

There are three fruit bat (Megachiroptera) species found in the Federal Islamic Republic of the Comores (Western Indian Ocean). These are the Comoros lesser flying fox, *Pteropus seychellensis comorensis* (Nicoll, 1908), Livingstone's flying fox, *Pteropus livingstonii* (Gray, 1866) and the Comoros rousette, *Rousettus obliviosus* (Kock, 1978). *P. s. comorensis* is abundant and is found on all four islands of the Archipelago (Cheke & Dahl 1981; Action Comores 1992, 1997). Little is known about the status of *R. obliviosus*, which has been recorded from Grande Comore, Moheli and Anjouan (Reason & Trehwella 1994). Of the three species, *P. livingstonii* is the rarest; it is found only on two of the four islands of the archipelago (Anjouan and Moheli) (Cheke & Dahl 1981; Reason & Trehwella 1994).

P. livingstonii was accorded the status Endangered (Priority Grade 1) in the IUCN Action Plan for Old World Fruit Bats (Mickleburgh, Hutson & Racey 1992). The IUCN Red List categories for animals were recently redefined (Mace & Lande 1991; IUCN 1996) and *P. livingstonii* is now categorized as Critically Endangered (A1c+2cd, B1+2c, C2a). A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of certain additional criteria (A to E), laid out in the IUCN Red List of Threatened Animals IUCN (1996). Mace & Lande (1991) believed that the old categories used in Red Data lists were too subjective. Hence they proposed their redefined categories in terms of the probability of extinction within a specific time period.

One of the major recommendations for the conservation of *P. livingstonii* in the Action Plan for Old World Fruit Bats was assessment and monitoring of the bat population. This project has been the priority of the non-governmental organization Action Comores, which was founded in 1992, and which is working closely with the

Comoran government, IUCN and Jersey Wildlife Preservation Trust in the conservation of this species. The aim of this paper is to present the latest survey results of Action Comores and to discuss these findings in relation to the IUCN criteria that categorize *P. livingstonii* as "Critically Endangered".

Roost Surveys and Habitat Requirements of Livingstone's Flying Fox

The status of Livingstone's flying fox was reviewed by Cheke & Dahl (1981). Their survey concluded that there were "no more than a few hundreds, and maybe less" of this species on Anjouan. Prior to this survey, there are only two published reports on the status of *P. livingstonii*. M. Humblot (cited in Milne-Edwards & Oustalet 1888) states that the bat "existed in abundance in the great forests which cover the summit of Anjouan's peak but is never seen in the lowland areas of the coast". Voeltzkow (1904) stated the bat was "rare" and seen "sometimes during the day flying above the tops of the highest mountains" but "is never seen in the banana plantations or the natives' gardens", unlike *P. s. comorensis*. Reports of sightings and surveys subsequent to that of Cheke and Dahl are summarized in Reason & Trehwella (1994) and Action Comores (1992).

Survey work in the dry seasons (June - August) of 1992, 1993 and 1994, by Action Comores personnel on expeditions from the United Kingdom, found two roost sites on Moheli and six on Anjouan. The maximum population estimate from these surveys was 20 bats on Moheli and 132 on Anjouan (Reason & Trehwella 1994). However, after these consecutive visits it became obvious that if such work was to be regular, repeatable and cost-effective, it had to be carried out by Comorans "*in-situ*", rather than by "*ex-situ*" scientists. In 1994 therefore, Action Comores established an *in-situ* roost monitoring programme (Action Comores 1995), which involved training groups of Comoran volunteers to survey the roosts. The *in-situ* survey protocol comprises twice-yearly visits (in the wet and dry seasons) to all known bat roosts, in order to undertake simultaneous counts of all bats. Each team of volunteers at each roost counts the bats they can see at around noon.

Table 1. summarizes the data from the 18th June 1995 biannual count on Anjouan. This gives a minimum noon population estimate for *P. livingstonii* on Anjouan

Table 1. Roost details and population counts for *P. livingstonii*.

Island	Roost	Altitude	Vegetation	count
Anjouan	Lingoni	690-800 m	Natural forest	103
	Hombo	780 m	Natural forest	7
	Dindi	780 m	Cultivation with dense tree cover	9
	Salamani	920 m	Cultivation under natural forest	85
	Plaideau's	450 m	Cultivation with light tree cover	0
	Enteritis	450 m	Cultivation	1
	Matulabe	580 m	Cultivation under natural forest	44
	Ouzini	1000 m	Natural forest	40
	Trondroni	650 m	Natural shrub/creepers	-
	Kangani	650 m	Cultivation under natural forest	43
Moheli	Ouallah I	150 m	Cultivation with dense tree cover	~ 60
	Mlédjélé	680 m	Natural forest	-

of 332 individuals from nine roosts. It was not possible to survey Moheli simultaneously, however, at least 60 *P. livingstonii* were counted at 13:00 on 7th July 1995 at the 'Ouahllah 1' roost on Moheli. A minimum population estimate on Anjouan in December 1996, from roost counts deemed to be reliable, was calculated as 372 *P. livingstonii*.

Table 1 also summarizes the positions of all known *P. livingstonii* roost sites. These positions were determined either by GPS or by triangulation, with information on vegetation type and altitude obtained from the Carte d'Occupation des Terres aux Comores (Agrar und Hydrotechnik 1987) and Carte de l'Archipelago des Comores (1/50000) (Institute Geographique National 1995).

Table 1 shows that all the roosts on Anjouan (maximum altitude 1595m) are at or above 450m in altitude, and that those on Moheli (maximum altitude 790m) are at or above 150m. The majority of roosts are in either a natural vegetation type or in an area of subsistence cultivation under natural forest, as judged from the Carte d'Occupation des Terres aux Comores. On Anjouan, no sightings have been made below 300m. On Moheli, bats have been seen feeding at a site with an altitude of 40m, and on one of the coastal islands. Preliminary investigations suggest *P. livingstonii* feeds more on native tree species than does *P. s. comorensis* (Action Comores 1992).

It seems reasonable to conclude from the data on roost preferences and sightings (see Fig. 1), and from the historical reports of M. Humblot (cited in Milne-Edwards & Oustalet 1888) and Voeltzkow (1904), that *P. livingstonii* is a species that prefers natural forest areas at higher altitudes.

***P. livingstonii* and the IUCN Red List Categories**

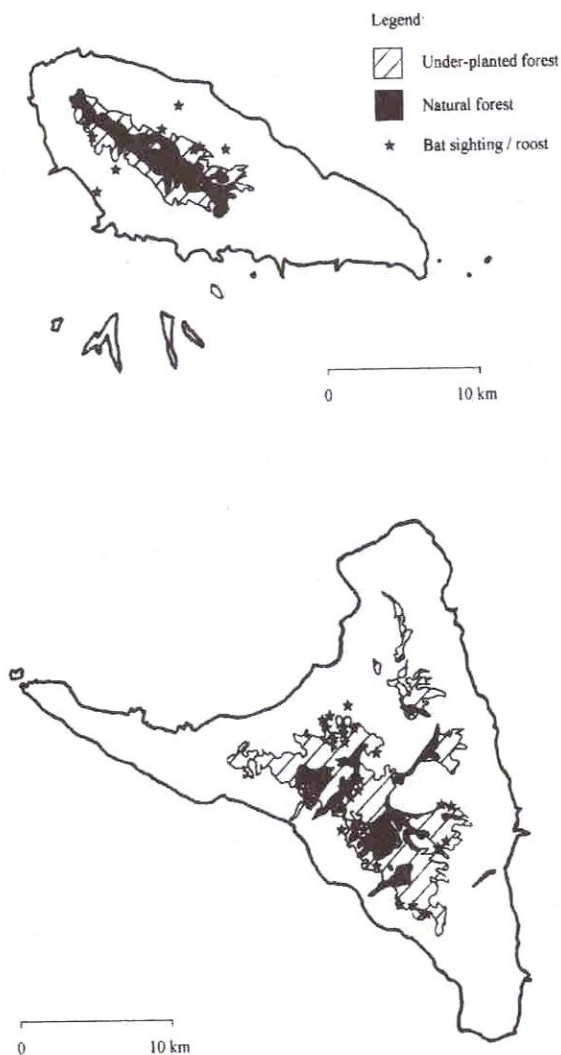
According to IUCN (1996), a taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by certain criteria (see below). These criteria are discussed for *P. livingstonii* in light of the recent survey work, and additional information on the biology of *P. livingstonii* and other *Pteropus* species.

Population reduction (Criteria: A1c+2cd)

A. Population reduction in the form of the following:

1. An observed, estimated, inferred or suspected reduction of at least 80 % over the last 10 years or three generations, whichever is the longer, based on (and specifying) any of the following:
 - a. direct observation
 - b. an index of abundance appropriate for the taxon
 - c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
 - d. actual or potential levels of exploitation
 - e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
2. A reduction of at least 80 %, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

Fig. 1 *P. livingstonii* sightings and roosts in relation to forest habitat.



Before commenting on any discussion on population reduction, it is necessary to estimate which is the longer for this species: 10 years or three generations? Pierson & Rainey (1992) reviewed *Pteropus* reproductive biology and found little variation in the observed patterns in 23 species. Females reach sexual maturity at 1.5 to 2.0 years, have only one offspring per year and have an average gestation period of 5.5 months. From

observations on captive *Pteropus*, females become sexually mature at about 2.5 years of age, the birth interval is just under one year, and the gestation period is six months (J. Seyjagat, *pers. comm.*). Thus generation time is around 2.5 to 3.0 years, and three generations may therefore be assumed to equate approximately to 10 years.

There is, as yet, insufficient direct survey data to comment on the population status of these bats over the last 10 years, although regular *in-situ* surveys may provide these data in the future. Regular monthly counts at one roost (Lingoni) between 1992 and 1996 show a stable population over this period.

There has been documented loss in the preferred forest habitat of this species, though again no recent habitat surveys exist. The area of natural forest on Anjouan has declined from 120km² in 1925, through 80.8km² in 1972 to 21.6km² in 1987. This represents a 73% loss in the time period 1972-1987. On Moheli, an area of 33.3km² of natural forest in 1969 has declined to 15.5km² in 1987, representing a 53% loss over this time period.

Without current estimates of the extent of natural forest, it is not possible to predict the present rate of forest habitat loss, but there is no cause for anything other than pessimism. Pressure on this habitat from Comorans seeking land for cultivation and timber for fuel and construction continues to increase. Cyclones may also pose a threat to the bats, either directly by injuring bats, or indirectly by damaging their roosts or feeding sites. In 1979, Mungroo (1979, cited in Carroll, 1988) estimated that cyclone Cleine II resulted in a 50 % reduction in the *P. rodricensis* bat population on Rodrigues Island. Cyclones have had a devastating effect on the vegetation of the Comoros Islands (Battistini & Vérin 1984), and a serious cyclone is recorded every 10 years or so, according to Benson (1960). Direct exploitation of the bats is probably the least important threat to *P. livingstonii*, as there is little evidence that this species is hunted at present (Action Comores 1992).

Extent of occurrence of *P. livingstonii* (Criteria: B1+2c)

B. Extent of occurrence estimated to be less than 100 km² or area of occupancy estimated to be less than 10 km², and estimates indicating any two of the following:

1. Severely fragmented or known to exist at only a single location.
2. Continuing decline, observed, inferred or projected, in any of the following:
 - a. extent of occurrence
 - b. area of occupancy
 - c. area, extent and/or quality of habitat
 - d. number of locations or subpopulations
 - e. number of mature individuals.
3. Extreme fluctuations in any of the following:
 - a. extent of occurrence
 - b. area of occupancy
 - c. number of locations or subpopulations
 - d. number of mature individuals.

An estimate for the potential extent of occurrence of this species is the total area of natural and underplanted forest on Anjouan and Moheli, since Fig. 1 shows a correlation between bat sightings and these forest types. This gives an area of 82.8km² on Anjouan and 34.6km² on Moheli; a total of 117.4km² as of 1987.

The area of natural forest on Anjouan has become fragmented as it has declined. Much of the central area around the mountain N'Tingui above 400m used to be covered in natural forest, but this is now limited to non-contiguous areas above 800m. The topography of Moheli is such that forest habitat loss has not resulted in such dramatic fragmentation.

The significance of this fragmentation cannot be determined without further studies on the feeding ecology and movements of this species. Other *Pteropus* species studied to date have been shown to feed on a wide variety of fruits and flowers (Pierson & Rainey 1992), although individual species show a preference for certain foods on a seasonal basis and can be regarded as "sequential specialists" (Marshall 1985). The implication of this for *Pteropus* in general is that, on islands with low floral diversity, the loss of critical plant species through deforestation may affect the survival of these bats (Pierson & Rainey 1992). This situation may apply to for *P. livingstonii* since the natural forest habitat has become so fragmented. Protection of the remaining natural forest patches should be considered as a major component of the long-term management of this species.

Clearly *P. livingstonii* exists in more than a single location, with at least 10 recorded roosts sites on Anjouan and two on Moheli. The two islands are 50km apart at their nearest point, although the distance between the two closest roosts on Anjouan and Moheli is nearer 90km. As an approximation, Rainey & Pierson (1992) state that island populations of *Pteropus* separated by more than 100km of open water will not experience movements sufficient to substantially influence population size.

Further studies will need to be undertaken to determine the rate of decline in the area, extent and/or quality of this species' preferred forest habitat.

Population size (Criterion: C2a)

C: Population estimated to number less than 250 mature individuals and either:

1. An estimated continuing decline of at least 25 % within 3 years or one generation, whichever is longer or
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:
 - a. severely fragmented (i.e. no subpopulation estimated to contain more than 50 mature individuals)
 - b. all individuals are in a single subpopulation.

The population estimate from the 12 known roosts is approximately 400 individual adult bats, based on counts in 1995 and 1996. The limited evidence from surveys since 1991 fails to show any directly observed current decline in bat numbers (Action Comores 1997).

It is believed that this estimate represents the majority of the total population. Most of Anjouan has now been surveyed, and it is unlikely that many more large roosts will be found. Although only one roost site was known in 1988, by 1992 this had increased to four and by 1995, as a result of the *ex-situ* and *in-situ* surveys, to 12. One potential 'new' roost area has been reported on Anjouan (Action Comores 1997) but not yet verified. Further roosts may exist on Moheli, as it is less well surveyed than Anjouan. The survey protocol (simultaneous counts at all known roosts) also reduces the possibility of bats moving between roosts during the count, and so affecting the accuracy of the count.

It is not known how (or whether) the *P. livingstonii* population is divided into sub-populations. The distances between the two islands are less than those suggested as delineating separate populations (Rainey & Pierson 1992). At least five of the roosts in the June 1995 count on Anjouan are of more than 50 bats, as is the largest roost on Moheli.

Conclusions

The survey work has produced a reliable minimum population estimate of around 400 individual *P. livingstonii* and shown that this species prefers natural forest areas.

This information is not sufficiently complete to verify the current IUCN category for this species, as it lacks sufficient detail on population stability and/or recent changes over the last 10 years in habitat quality. However a provisional assessment of the IUCN category can be made. The classification Critically Endangered (A1c+2cd, B1+2c, C2a) seems over-cautious for several reasons. There is no evidence for any dramatic population decline over the last 10 years and, although habitat destruction continues, it is unlikely to have been at the rate of 80% in this time period. The extent of occurrence is likely to exceed 100km² and the population exists on two islands and at 12 roosts. The population exceeds 250 mature individuals and several of the roosts regularly contain more than 50 bats. It would seem more logical, therefore, from the available data to classify *P. livingstonii* as Endangered (A1c +2cd, B1+2c, C2a). The additional criteria are similar to those of the Critically Endangered category, except that (A) population reduction is of 50% over 10 years / three generations, (B) extent of occurrence is estimated to be less than 5000km² and (C) the population is estimated to be less than 2500 mature individuals.

This study clearly reveals where further work is needed if an accurate assessment of the IUCN Red List categories is to be made, and if the long-term conservation of this species is to be assured.

- Long-term population monitoring is essential and it is planned to reinforce the *in-situ* monitoring scheme in 1998. Population and Habitat Viability Analyses (PHVA) could help predict future population trends, though such modelling studies will be dependent on the quality of data available.
- Up-to-date, and repeatable, vegetation cover maps are needed to assess the rates of habitat loss. A GIS project to assess habitat requirements is planned for 1998.

- There is no information on the population dynamics and age structure of *P. livingstonii*. This paucity of information unfortunately extends to almost all *Pteropus* species.
- There is no knowledge of what constitutes a subpopulation for *P. livingstonii*, or the degree of movement between roosts and / or islands.
- More information is needed on the feeding ecology of *P. livingstonii*; specifically to see if the fragmented forest cover poses a threat to provision of a reliable food supply throughout the whole year.

Mace & Lande (1991) suggest that a species should be downgraded in category (i.e. from Critically Endangered to Endangered) only when the criteria of the lower risk category have been satisfied for a time period equal to that spent in the original category, or if it is shown that past data were inaccurate. The survey work outlined here suggest the latter reason for down grading *P. livingstonii*, although it might be wise to wait for the results of further surveys, the GIS project and PHVA analyses before this is done.

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An Annotated Checklist of the Chagos Archipelago Terrestrial Fauna (Omitting Birds) Recorded During the 1996 'Friends of the Chagos' Expedition

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Abstract: An annotated checklist of the terrestrial fauna (omitting birds) is documented. It includes 94 species of insect, one species of amphibian, two species of terrestrial reptile and three species of mammal.

Keywords: Chagos, Indian Ocean, Diego Garcia, Insecta, Amphibia, Reptilia, Mammalia

Introduction

The Chagos Archipelago, British Indian Ocean Territory, centred at 6 degrees south, 72 degrees east, in the middle of the Indian Ocean (Edis 1993), is the largest and most isolated coral atoll complex in the world (Pearce 1994). The nearest land to the Chagos is Addu Atoll in the Maldives which is 600km to the north. Mahe, the main island of the Seychelles, is 1,770km to the west and Mauritius is 1,930km to the west. There are five islanded atolls within the Chagos: Diego Garcia; Egmont; the Great Chagos Bank; Peros Banhos and Salomon. The total land area is estimated to be less than 60km² (Symens 1996). The largest island is the main island of the Diego Garcia Atoll which is approximately 27km² (Symens 1996). The islands have a tropical maritime climate.

During February and March 1996, L. K. Barnett and C. Emms surveyed 24 of the 58 islands of the Chagos Archipelago for insects as members of the 1996 'Friends of the Chagos' international scientific expedition (Barnett & Emms 1996). This paper constitutes an annotated checklist of the terrestrial fauna that they recorded during the expedition. There was no attempt made to record molluscs or arachnid species during the 1996 expedition. Previous records of these groups are detailed in Stoddart (1971). The bird species recorded are documented separately in Symens (1996) and Symens (in prep).

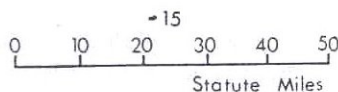
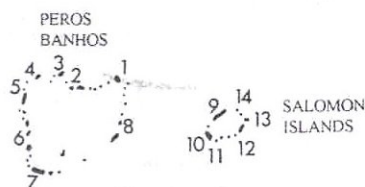
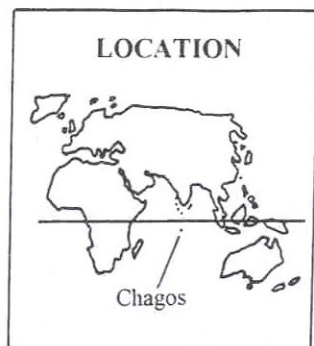
Annotated Checklist

Class: Insecta

Odonata

Anax guttatus (Burmeister, 1839). Previously unknown from Chagos. This large dragonfly was only recorded on Iles Diamante, Yeye and the Morseby Islands in the Peros Banhos Atoll. Prey items included the Gram Blue butterfly *Euchrysops cnejus* (Barnett & Emms 1997b).

THE CHAGOS ARCHIPELAGO



Key

Peros Banhos:

- 1 = Isle Yeye
- 2 = Isle Parasol
- 3 = Moresby Islands
- 4 = Isle Diamant
- 5 = Petite Isle Mapou
- 6 = Isle Petite Soeur
- 7 = Isle du Coin
- 8 = Isle Petite Coquillage

Salomon:

- 9 = Isle Anglaise
- 10 = Isle Boddam
- 11 = Isle Poule
- 12 = Ile Sepulture
- 13 = Isle Takamaca
- 14 = Isle de la Passe

Great Chagos Bank:

- 15 = Nelson
- 16 = North brother
- 17 = Middle Brother
- 18 = South Brother
- 19 = Danger Island

Egmont:

- 20 = Isle Lubine

Diego Garcia:

- 21 = Downtown
- 22 = Point Marianne
- 23 = Incinerator
- 24 = Minni-minni

DIEGO GARCIA

(C180 km south of Peros Banhos)

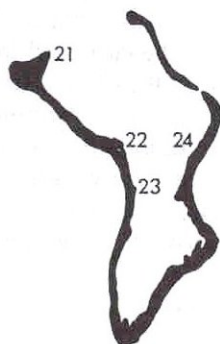


Fig. 1. Islands of the Chagos group

Diplacodes trivialis (Rambur, 1842). This small dragonfly was recorded on islands in the Salomon and Egmont Islands, and also on the main island of Diego Garcia. Large populations were present at all of these locations.

Ischnura senegalensis (Rambur, 1842). This damselfly was recorded on Diego Garcia and Ile Lubine in the Egmont Atoll in low numbers.

Macrodiplax cora Brauer, 1867. Previously unknown from Chagos. Two specimens of this medium-sized nocturnal dragonfly were recorded on Diego Garcia when they were attracted to the insect catch of a light trap, run overnight.

Pantala flavescens (Fabricius, 1798). This highly migratory dragonfly was only recorded on Diego Garcia where there was a substantial population present.

Tramnea limbata Desjardins, 1832. This dragonfly was recorded on Diego Garcia where there was a large population present over most of the island, and also on Ile Lubine in the Egmont Atoll.

Orthoptera

Acheta domesticus Linnaeus. Previously unknown from Chagos. This house cricket was found only on Diego Garcia, where it was associated closely with human dwellings.

Aiolopus s. simulatrix Walker. This grasshopper was recorded on eleven islands throughout the Chagos and found on every atoll. Large populations were present wherever there was short vegetation.

Attractomorpha acutipennis (Guerin). Previously unknown from Chagos. This species was only recorded on the main island of Diego Garcia, from a single location.

Conocephalus maculatus (Guillou). Previously unknown from Chagos. This cricket was only recorded on Iles Boddam and Takamaka in the Salomon Atoll. There appeared to be thriving populations present on both islands.

Euconocephalus chagosensis (Bolivar, 1913). This species was only recorded on South and Middle Brother in The Great Chagos Bank Atoll.

Phaneroptera nana Fieber, 1853 *sparsa* Stal. Previously unknown from Chagos. This species was only recorded from the main island of Diego Garcia, where there appeared to be a thriving population at at least one site.

Dictyoptera

Blattella germanica (Linnaeus). This cockroach was recorded from two widely dispersed locations in the archipelago: Ile Takamaka in the Salomon Atoll and Middle Brother in The Great Chagos Bank Atoll. On both islands it was found to be nocturnal.

Blattellidae sp. An unidentified species only recorded on Ile Takamaka in the Salomon Atoll.

Margattea longicercata Bolivar. Previously unknown from Chagos. This cockroach was recorded from only one location: Ile du Coin in the Peros Banhos Atoll.

Periplaneta americana (Linnaeus). This large cockroach was recorded on Ile Takamaka in the Salomon Atoll and the main island of Diego Garcia. On both islands it was observed at night in large numbers amongst the vegetation of the islands. On Diego Garcia it was also recorded frequently in human accommodation blocks.

Pycnoscelus indicus (Fabricius). This cockroach was only recorded from Ile Boddam in the Salomon Atoll.

Hemiptera

Cantheconidea furcellata (Wolfe). Previously unknown from Chagos. This species was only recorded from Ile Parasol in the Peros Banhos Atoll.

Pondskater spp. Previously unknown from Chagos. A small population of this species was recorded in a fresh-water ditch at the landfill site on Diego Garcia. Only nymphs were captured and these could not be identified down to species level.

Lepidoptera

Adoxophyes privatana Walker. Previously unknown from Chagos. This moth was only recorded on Middle Brother in the Great Chagos Bank Atoll.

Agrius convolvuli Linnaeus, 1758. This large hawkmoth was recorded from Ile Petite Coquillage in the Peros Banhos Atoll and from Middle Brother in the Great Chagos Bank Atoll.

Amyna natalis Walker. Previously unknown from Chagos. This moth was only recorded on Middle Brother in the Great Chagos Bank Atoll.

Anomis sabulifera Guenee. This moth was only recorded from the main island of Diego Garcia.

Anticarsia irrorata Fabricius. Previously unknown from Chagos. This moth was only recorded on Ile du Coin in the Peros Banhos Atoll.

Bradina admixtalalis Walker. This moth species was only recorded on Ile du Coin in the Peros Banhos Atoll.

Callopietria maillardi Guenee. This moth was recorded from two widely separated islands: Ile Boddam in the Salomon Atoll and the main island of Diego Garcia.

Chasmina candida Walker, 1865. This large white moth was found to be common on the perimeters of many islands in the Salomon and Peros Banhos atolls and also on the main island of Diego Garcia. It appeared to be closely associated with its larval foodplant the Takamaka tree *Calophyllum inophyllum*.

Chrysodeixis eriosoma Doubleday, 1843. This moth was recorded on Iles Boddam and Takamaka in the Salomon Atoll and Middle Brother in the Great Chagos Bank Atoll.

Chrysodeixis illuminata Robinson. Previously unknown from Chagos. This moth was only recorded on Ile de la Passe in the Salomon Atoll.

Comostola p. pyrrhoga Walker. This moth was only recorded on the main island of Diego Garcia.

Cryptophlebia encarpa Meyrick. This moth was only recorded on the main island of Diego Garcia.

Diaphania indica Saunders, 1851. This moth was only recorded on the main island of Diego Garcia.

Eilema antica Walker. This moth was recorded in good numbers on Iles Boddam and Takamaka in the Salomon Atoll, Ile du Coin in the Peros Banhos Atoll and on the main island of Diego Garcia.

Endotricha m. mesenterialis Walker. This small moth was recorded on two widely separated islands: Ile Takamaka in the Salomon Atoll and the main island of Diego Garcia.

Euchrysops cnejus Fabricius. Previously unknown from Chagos. This small blue butterfly was found to have large populations on many of the islands visited excluding those in the Egmont Atoll (where it was not recorded). It was also recorded at the land-refill/incinerator site on Diego Garcia. This butterfly appears to be a recent addition to the Chagos fauna and may well have been aided in its dispersal by the rapid colonisation of its main larval foodplant *Vigna marina* on the northern atolls during the last decade. Interestingly its larval foodplant on Diego Garcia was *Macroptilium lathryoides*.

Herpetogramma licarsisalis Walker, 1859. This moth was only recorded on the main island of Diego Garcia.

Hippotion velox Fabricius, 1793. This medium-sized hawkmoth was only recorded on Middle Brother in the Great Chagos Bank Atoll.

Hyblaea puera Cramer. Previously unknown from Chagos. This moth was only recorded on Ile Boddam in the Salomon Atoll.

Hydriris ornitalis Duponchel. Previously unknown from Chagos. This moth was only recorded on Ile du Coin in the Peros Banhos Atoll and on the main island of Diego Garcia.

Hypolimmus bolina euphonoides Linnaeus, 1764. This large butterfly was recorded from Iles Anglaise, Takamaka and de la Passe in the Salomon Atoll, and South Brother, North Brother and Danger Island in the Great Chagos Bank. The males of this species appear to be highly territorial and only small numbers were noted on each island. The subspecies *euphonoides* is endemic to the Chagos (Barnett & Emms 1998; Poulton 1924).

Junonia villida chagoensis Fabricius, 1787. This butterfly was recorded on eight islands in the Salomon, Peros Banhos and Great Chagos Bank atolls. In contrast to *H. bolina*, it was found in substantial numbers on most of the islands where it was recorded, not only as the adult butterfly but also as larva on the foodplant *Scaevola sericea*. The subspecies *chagoensis* is endemic to the Chagos (Barnett & Emms 1998; Watkins 1925).

Lamprosema niphealis Walker. This moth was recorded on Ile Boddam in the Salomon Atoll and Middle Brother in the Great Chagos Bank Atoll.

Macroglossum corythus oceanicum Walker, 1856. This medium-sized hummingbird hawkmoth was recorded on Iles Boddam and Takamaka in the Salomon Atoll and North Brother, Nelson and Danger Islands in the Great Chagos Bank Atoll. It was recorded in very high numbers and the population appears to be strong on these islands. The subspecies *oceanicum* is endemic to the Chagos (Barnett *et al.* in press).

Mocis frugalis Fabricius, 1775. This species was only recorded on the main island of Diego Garcia.

Omiodes indicata (Fabricius). Previously unknown from Chagos. This moth was only recorded on Ile du Coin in the Peros Banhos Atoll.

Omiodes poeonalis Walker. Previously unknown from Chagos. This species was only recorded on the main island of Diego Garcia.

Parotis suralis Lederer. This moth was only recorded on Ile Takamaka in the Salomon Atoll.

Petroleae dana de Niceville, 1883. This small blue butterfly was only recorded from the nature reserve area on the main island of Diego Garcia. Two individuals were observed and it appears to be surviving in low numbers.

Sameodes cancellalis Zeller. Previously unknown from Chagos. This species was only recorded on the main island of Diego Garcia.

Spodoptera litura Fabricius, 1775. This moth was only recorded on Middle Brother in the Great Chagos Bank Atoll.

Spodoptera mauritia acronyctoides Boisduval. This species was only recorded on the main island of Diego Garcia.

Spoladea recurvalis Fabricius. Previously unknown from Chagos. This moth was only recorded on South Brother in the Great Chagos Bank Atoll.

Stictoptera hironisii. This species was recorded on Ile Takamaka in the Salomon Atoll and from Minni-minni on the main island of Diego Garcia. Three female specimens were taken at light and proved to be a new species to science. A previously unidentified male specimen from an earlier expedition that was captured and preserved by Mr Mont Hiron was found upon return to the United Kingdom and is now the holotype of this species lodged at the British Museum of Natural History in London (Barnett, Emms & Holloway in press). It is likely that this species is endemic to the Chagos.

Synclera univocalis (Walker). Previously unknown from Chagos. This moth was only recorded on Ile du Coin in the Peros Banhos Atoll.

Utetheisa pulchelloides Hampson. This brightly-coloured day-flying moth was recorded on 14 of the islands surveyed and was found to occupy islands in every atoll of the Chagos. It was present in very large numbers and larvae were noted on several plants of *Tournefortia argentea*.

Vanessa cardui Linnaeus, 1758. Previously unknown from Chagos. This well-known migratory butterfly was recorded on Ile Lubine in the Egmont Atoll. Only a single specimen was observed and no larval foodplants of this species have been recorded on the islands of the Chagos (Topp 1988).

Diptera

Clinopogon nicobarensis (Schiner). This robber fly was recorded on all atolls apart from Diego Garcia. It appeared to favour the strand line on the islands perimeter beaches.

Musca domestica Linnaeus. Previously unknown from Chagos. This fly was only recorded from the main island of Diego Garcia.

Chrysomya megacephala (Fabricius). This fly was recorded on Iles Diamante and Yeye in the Peros Banhos Atoll, the main island of Diego Garcia and Nelson Island in the Great Chagos Bank Atoll.

Chrysosoma leucopogon (Wiedemann). This fly was recorded on Ile Yeye and Moresby Islands in the Peros Banhos Atoll, the main island of Diego Garcia and Nelson Island and South Brother in the Great Chagos Bank Atoll.

Eristalinus laetus (Wiedemann). Previously unknown from Chagos. This hoverfly was only recorded on the main island of Diego Garcia.

Homoneura sp. Previously unknown from Chagos. This species was recorded on several islands in the Peros Banhos and Great Chagos Bank atolls, as well as on the main island of Diego Garcia.

Pygophora respondens (Walker). Previously unknown from Chagos. This fly was only recorded on the main island of Diego Garcia.

Sarcophaga dux Thomson. This fly was only recorded on Ile Poule in the Salomon Atoll.

Sarcophaga peregrina (Robineau-Desvoidy). This fly was only recorded on Ile Diamante in the Peros Banhos Atoll.

Scholastes cinchus Guerin. This fly was recorded on all Chagos atolls (14 islands in total) and appeared to be abundant wherever it was observed.

Hymenoptera

Ampulex sp. probably *A. concessa* (Fabricius). This species was only recorded from the main island of Diego Garcia.

Apis mellifera Linnaeus. This honeybee was only recorded from the main island of Diego Garcia. It appeared to be common throughout the island and a nest was observed in a hollow tree at Point Marianne.

Camponotus sp. probably *C. maculatus* Forel. This species was recorded on several islands in the Salomon and Peros Banhos Atolls, as well as on the main island of Diego Garcia.

Chalicodoma sp. Previously unknown from Chagos. This species was recorded on two widely separated islands, Ile Boddam in the Salomon Atoll and the main island of Diego Garcia.

Chalybion bengalense (Dahlbom). This species was only recorded on Iles Boddam and Anglaise in the Salomon Atoll.

Eumenidae sp. 1 This species was recorded in every atoll of the Chagos (10 islands in total).

Eumenidae sp. 2 This species was only recorded on Ile Sepulture in the Salomon Atoll.

Eumenidae sp. 3 This species was recorded on the main island of Diego Garcia and South Brother in the Great Chagos Bank.

Eumenidae sp. 4 This species was only recorded from the main island of Diego Garcia.

Eumenidae sp. 5 This species was only recorded from the main island of Diego Garcia.

Paratrechina bourbonica (Forel, 1886). This species was recorded on two widely separated islands: Ile Boddam in the Salomon Atoll and the main island of Diego Garcia.

Paratrechina longipes Forel. Previously unknown from Chagos. This species was only recorded on Ile Boddam in the Salomon Atoll.

Pison sp. This species was only recorded from the main island of Diego Garcia.

Polistes sp. probably *P. olivaceus* (Degeer, 1773). This species of yellow wasp was the most widespread of all the Chagos insect species recorded. It was observed on 23 islands located in every atoll on the Chagos. It appeared to be very numerous and also aggressive. This was the only wasp that regularly stung members of the expedition.

Ponerini sp. Previously unknown from Chagos. This species was only recorded on Ile Boddam in the Salomon Atoll.

Rhopalidia sp. Previously unknown from Chagos. This species was only recorded from the main island of Diego Garcia.

Sphex sericeus (Fabricius). Previously unknown from Chagos. This species was only recorded from the main island of Diego Garcia.

Technomyrmex albipes (Smith, 1861). This was recorded on two widely separated islands. Ile Anglaise in the Salomon Atoll and the main island of Diego Garcia.

Xylocopa sp. This carpenter bee was only recorded from the main island of Diego Garcia where it was mainly observed at the plantation site.

Coleoptera

Ananca aldabrana Champion, 1917. This species was recorded on Ile Takamaka in the Salomon Atoll, Petite Ile Mapou in the Peros Banhos Atoll and on the main island of Diego Garcia.

Cheilomenes sexmaculatus (Fabricius). This species was recorded on Iles Poule and Takamaka in the Salomon Atoll.

Coccinella transversalis Fabricius. Previously unknown from Chagos. This ladybird was only recorded on the main island of Diego Garcia.

Colaspoma rugiceps Lef. Previously unknown from Chagos. This species was only recorded on the main island of Diego Garcia.

Cratopus adpersus Waterhouse. This species was recorded on 11 islands in all atolls of the Chagos.

Exochomus nigrita Previously unknown from Chagos. This ladybird was only recorded on the main island of Diego Garcia.

Gametis versicolor Fabricius. This medium-sized beetle was only recorded on Ile Parasol in the Peros Banhos Atoll. It appeared to associate with *Tournefortia argentea* and several adults were observed feeding on the pollen of this shrub.

Melanoxanthus sp. probably *M. puerulus* Candeze. This species was only recorded on the main island of Diego Garcia.

Oryctes rhinoceros (Linnaeus). This large beetle was only recorded on the main island of Diego Garcia and South Brother in the Great Chagos Bank. It is a pest of *Cocos nucifera* and its history on the Chagos has been well documented (Hutson 1981).

Platynaspis capicola Crotch. This species was only recorded on the main island of Diego Garcia.

Class: Amphibia

Bufo marinus Linnaeus, 1758. Several specimens of an unidentified toad were bought back from the expedition and are lodged with the British Museum Natural History (Barnett & Emms 1997a). A series of more than one hundred specimens collected from Diego Garcia, lodged at the Smithsonian Institution in Washington, have been identified as *B. marinus* (pers. comm. Ronald I. Crombie). It is likely therefore that both series are of the same species. This toad was only recorded in 1996 on the main island of Diego Garcia, where it was very common. Many tadpoles were also recorded in fresh water habitats on the island.

Class: Reptilia

Hemidactylus frenatus Dumeril & Bibron. This gecko was recorded on Iles Boddam and Poule in the Salomon Atoll, Iles Diamante, Yeye and Moresby Islands in Peros Banhos Atoll, on the main island of Diego Garcia and on Danger Island on the Great Chagos Bank Atoll. It appears to be a widespread but uncommon animal throughout most of the Chagos.

Lepidodactylus lugubris Dumeril & Bibron. This gecko was recorded on Ile Takamaka in the Salomon Atoll, Ile du Coin in the Peros Banhos Atoll and on the main island of Diego Garcia. It appeared to be nocturnal and in the Downtown area of Diego Garcia at least, also appeared to be very numerous.

Class: Mammalia

Felis catus Linnaeus, 1758. This species was recorded on Ile Boddam in the Salomon Atoll, Ile du Coin in the Peros Banhos Atoll and on the main island of Diego Garcia. The cats on Diego Garcia are most numerous and appear to be semi-domesticated while the animals on the other atolls appear to be wholly feral.

Rattus rattus (Linnaeus, 1758). This species of rat was recorded on most of the islands in the Chagos, sometimes in very large numbers. Its presence appears to be a prime factor in regulating the number of sea-birds that breed on each island (Bellamy 1979; Symens 1996). It is unknown what effect it is having on invertebrates or the slowly recolonising native vegetation, but this is likely to be significant as the species is omnivorous (MacDonald & Barrett 1993; Symens 1996).

Equus asinus Linnaeus, 1758. Feral Donkeys were recorded on the main island of Diego Garcia where a small population is tolerated. Feral animals were also recorded on Ile du Coin in the Peros Banhos Atoll.

Additional Notes

Two species of land crab were recorded that are terrestrial in the adult phase of their life cycle. These were the coconut crab *Birgus latro* (Linnaeus, 1766), which was present throughout the islands of the archipelago with a thriving population (Barnett *et al.* in press), and *Cardisoma carnifex* (Herbst), which was only present, albeit in very high numbers, on the main island of Diego Garcia, where it was often encountered as a casualty on the main road around the island.

Acknowledgements

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A short study of the wedge-tailed shearwater (*Puffinus pacificus*) on Cousine Island, Seychelles.

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Abstract: The size of the colony of wedge-tailed shearwaters (*Puffinus pacificus*) on the island of Cousine in the central Seychelles was estimated for the first time, using belt transects and quadrat counts. The results indicate that Cousine hosts the second largest colony in the central Seychelles, smaller only than the one on Cousin. A ringing study performed at the same time show a high return rate between the 1996 and 1997 breeding season.

Keywords: Wedge-tailed shearwater, Cousine, population estimate, return rate, population density

Introduction

The wedge-tailed shearwater (*Puffinus pacificus* Gmelin, 1789) has a widespread distribution across the Pacific and Indian Oceans. Within the Seychelles archipelago it breeds on islands in the central Seychelles and the Amirantes (Diamond 1994). The largest known colonies in Seychelles exist on Aride and Cousin (Diamond 1994; Stoddart 1984), both of which are rat-free (Racey & Nicoll 1984). Since the eradication of a population of cats in the 1980's (Laboudallon 1984), the island of Cousine is now the only island in the central Seychelles devoid of alien mammals. There is an established colony of wedge-tailed shearwaters on the island (Penny 1974), however its size has never been determined.

Copsey (1997), in a census of lesser noddies (*Anous t. tenuirostris* Temminck, 1815), divided Cousine into three principle areas: a coastal plateau on the eastern side, a forested hill region and an unforested coastal rim, which, together with the beach, encircles the island. He provided baseline figures for the number of shearwaters nesting in the forest, but as this study was directed at lesser noddies, the unforested coastal rim was not taken into account, due to a lack of suitable nest sites for this species. As the wedge-tailed shearwater breeds in burrows (Penny 1984), the abundance of rocks and the availability of soil makes this area ideal nesting ground for this species.

The following study was conducted to determine a more comprehensive estimate for the wedge-tailed shearwater population breeding on Cousine. A ringing and biometric study was performed to aid in the long-term monitoring of the species on Cousine.

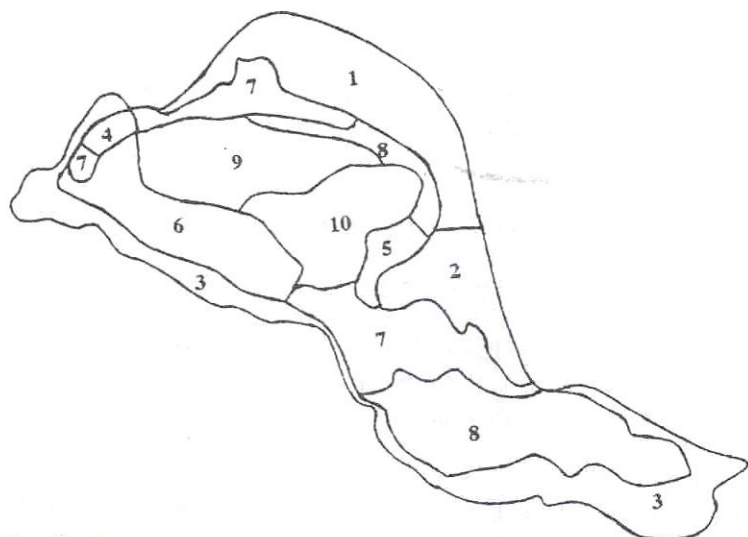


Fig. 1: The distribution of the major vegetation types on Cousine island (simplified from Bourquin 1997). 1: Plateau (open vegetation), 2: garden and houses, 3: bare rock, 4: bare rock and grasses, 5: cleared bamboo, 6: *Pandanus*, 7: *Pisonia grandis* woodland (sheltered), 8: *Pisonia* - *Ficus* spp. (sheltered), 9: *Euphorbia pyrifolia* - *Ficus* spp., 10: *Ficus/Ficus* - *Pisonia* (exposed).

Methods

The survey was conducted between 22 and 23 August 1997. At this time of the year the shearwaters should have been constructing burrows (Stoddart 1984; Penny 1974). The estimated numbers of pairs are based on the number of apparently occupied burrows (Bibby et al. 1992) as this takes account of birds that were absent during the count. A vegetation map (Fig. 1) was used to identify the different areas and estimate their sizes, using a grid constructed from the map scale. A preliminary study of the eastern coastal plateau failed to find any nesting wedge-tailed shearwaters, so the total island population was considered to be limited to the forested hill region and the unforested coastal rim.

To census the forested hill region Copsey (1997) used twenty-six 20×20 metre quadrats. Within these he counted the number of shearwaters seen. No account was taken of nest site abundance. As the unforested coastal rim is less than ten metres wide in certain places, a belt transect methods was considered to be a more practical alternative to sample this area than quadrats. Each of the 269 (14×14 metre) grid squares lying within (or partially within) the study area were numbered consecutively. Twenty-seven of these (±10%) were selected using a calculator to generate random numbers. The squares were located on the ground using the map and in each a 10×2 metre belt transect was laid. Transects started from the middle of the square and the direction in which it was laid was decided randomly by picking cards labelled North, South, East or West. In squares that overlapped with the sea or forest, the transect started at the border of that region and followed one of three possible directions: along

the border at either side of the fieldworker or out into the study area. This was done to ensure that the edge of the unforested region was also included in the survey. None of the squares overlapped with both the sea and the forest.

Within each of these 20m² transects the number of adult birds and the number of apparently occupied burrows were recorded. A burrow was considered to be occupied if there were signs of a scrape, droppings or feathers, a method used in censusing Manx shearwaters in the U.K. (Bibby et al. 1992). Burrows were only counted when their entrances fell within the transect. Each transect was surveyed twice by two fieldworkers.

By comparing the total number of birds seen to the numbers of burrows a ratio of birds : burrows was determined. Assuming that the ratios within the forested and unforested regions of the island were similar, the number of apparently occupied burrows in the forested region could be calculated. There were no clear indications that the densities in the two areas differed greatly. Finally, an island population estimate was calculated, based on the assumption that each apparently occupied burrow represented a breeding pair.

During 22 to 24 August 1997 a total of 30 wedge-tailed shearwaters were caught by hand after dark (mostly between 21:00 and 23:00). The birds were ringed, weighed and measured (wing, tail and tarsus) before release.

Results

I. Census

A summary of the number of birds and burrows found within each region of the island is given in Table 1.

The estimated number of nesting pairs is equal to the estimated number of apparently occupied burrows. Therefore the total estimated population of wedge-tailed shearwater on Cousine in 1997 is 31,095 pairs.

II. Biometric study

A total of 31 birds were caught, including 5 (16%) recaptures from 97 birds ringed on the island by G. Rocamora in 1996. All five recaptures were in areas where the 1996 ringing group had been ringing. If the six unbanded birds caught in a different part of the island in 1997 are excluded, the proportion of recaptures becomes even higher:

Table 1: The total number of birds found and the estimated number of burrows for the different vegetation zones of Cousine Island.

Region	Approx. area (m ²)	no. of birds	est. no. of burrows
Forested hill	165,586	426	23,844*
Unforested coast	41,200	27	7,251
Coastal plateau	50,214	0	0
Total	257,000	453	31,095

* figure calculated from a bird : burrow ratio of 0.284 derived from the unforested coastal rim.

Table 2: Biometrics of the wedge-tailed shearwater on Cousine Island.

Measurement	This study (mean \pm s.e.; n=30)	Maclean (1993) (mean)	P-value (T-test)
Tarsus	48.6 \pm 0.2	46 (n=20)	< 0.001
Wing	288.6 \pm 0.9	290 (n=21)	n.s.
Tail	13.0 \pm 0.1	12.6 (n=20)	<0.001
Weight	371.2 \pm 4.9		

20%. Measurements were taken from all but one recaptured bird. These are summarised in table 2, together with data from Maclean (1993).

The weights in 1997 were significantly heavier than those of the birds caught in 1996 (mean for 1996 = 342.3 \pm 2.7g., n=94; paired sample T-test: P<0.001).

Discussion

The only islands in the Seychelles for which population estimates were available were Cousin and Aride: 35,000 and 20,000 pairs, respectively (Diamond 1994). The results of this study have revealed Cousine to hold a significant proportion of the population of wedge-tailed shearwater breeding in central Seychelles. Both Cousine, Cousin and Aride are granitic islands with a rugged topography (Braithwaite 1984). Perhaps not surprisingly Cousin and Cousine, which are of similar size (28.6 and 25.7ha, respectively), play host to very similar densities of wedge-tailed shearwater: 0.12 pairs per m², for both Cousin and Cousine). Aride, which is much larger (68ha), has a much lower density of 0.03 pairs per m². It is not clear what causes this difference. The forest on Aride has a thicker soil than on both of the other islands (K. Kraaijeveld pers. obs.), which might be less suitable for breeding wedge-tailed shearwater. The other species of shearwater breeding on the Seychelles, Audubon's (*Puffinus lherminieri* Lesson, 1893), however is much more common on Aride than on Cousine (K. Kraaijeveld pers. obs.). It is noteworthy that at the time of the cat eradication program on Cousine Audubon's was the common species and wedge-tailed more scarce, while now the situation is reversed (P. Hitchins, pers. comm.).

In spite of the small sample size, return rates to Cousine appear to be very high and the shearwaters seem to be faithful to their nesting site between years. The Cousine population appears to be significantly longer-legged and -tailed than those sampled by Maclean (1993), but this may well prove to be a difference in measuring technique, especially since the wing lengths do not differ. More interesting is the observation that the same population averaged heavier in 1997 than in 1996. Several factors might account for this difference, for example the earlier sampling date in 1996 (July), which would imply that the shearwaters gain weight during the start of the breeding season. Food supply may also have been better in 1997 than in 1996, which, in view of the generally poor season for lesser noddies, would be surprising. More data are needed to answer these questions.

The results of this study stress the importance of the islands of Aride, Cousin and Cousine for the protection of seabirds breeding in the Seychelles.

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A study of habitat structure and vegetation in Seychelles

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Abstract: A quantified study of the habitats of the granitic Seychelles islands is used to propose an objective habitat classification. Each defined habitat is described and data on temporal changes are discussed.

Keywords: habitat, forest structure

The granitic islands of Seychelles are well known for their unique flora. Interest in the evolution of these continental islands and their conservation has resulted in descriptions of the main habitats currently found in the islands (Jeffrey 1962; Procter 1984; Gerlach 1993). These have been based on subjective impressions of the boundaries between habitat types and there are no published habitat accounts based on quantitative data with the exception of the studies of 'inselberg' biogeography (Flieschmann *et al.* 1996), forest regeneration (Flieschmann 1997) and invasion (Gerlach 1993b, 1996). The importance of recognising specific habitats and understanding the dynamics of vegetation change in the islands prompted the present study which represents the most exhaustive collection of quantitative habitat data for the islands.

Methods

36 sites were studied on the islands of Mahé, Silhouette, Praslin, Aride, Curieuse and La Digue (Fig. 1.). At each site 10 quadrats were used to record the number of each plant species over 2m high. The quadrats measured 5×5m and were centred on a randomly located point. Additional studies on herbaceous vegetation and canopy cover were carried out in these quadrats, but are not reported on here.

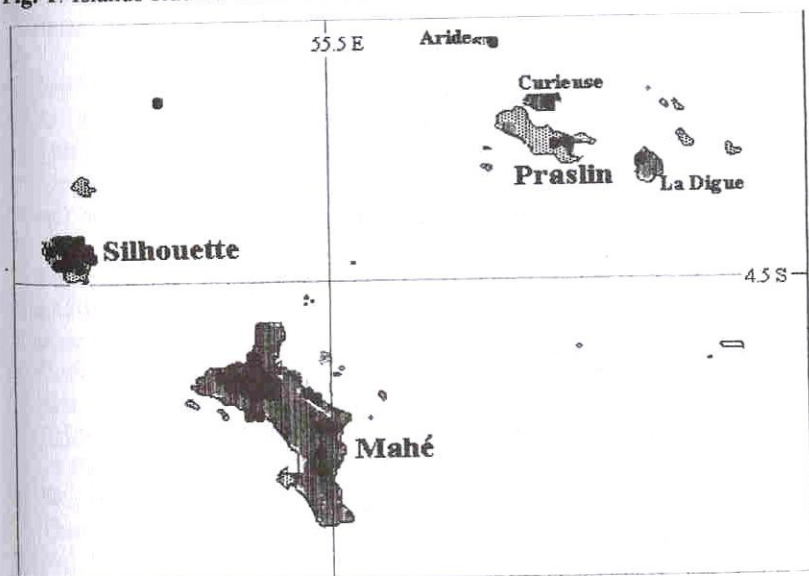
Most recent habitat classification studies have used cluster analysis methods to group similar habitats. These methods are appropriate to situations where habitats are well defined as a result of discrete external variables, such as geochemistry. In situations where external variables are effectively constant and the areas concerned are small (characteristics applying to Seychelles) cluster methods fail to provide robust classifications. The data from the 5×5m quadrats were analysed using the phylogenetic analysis program Hennig86 (Farris 1988). This detects phylogenetic groupings from character data and was used to provide a classification that reflects similarity in data sets and provides some indication of the most likely transitions.

Results

Data were coded using a geometrical series ($0=0$, 1 per quadrat =1, 2=2, 3-4=3, 5-8=4, 9-16=5, 17-32=6, 33-64=7, 65-128=8, 129-256=9). Data analysis using additive characters and a branch-and-bound algorithm produced 3 equally parsimonious patterns of relationships of 827 steps, consistency and retention indices of 0.53. A strict consensus of these groups the sites as shown in Fig. 2.

This provides a series of recognisable groupings with the exception of the group comprising the Vallée de Mai, Mare aux Cochons, Mont Dauban and Mon Plaisir (9-12). Four different habitats are found in this group, all dominated by plant species not found to any significant extent within the other habitat groups. If all *Palmae* are grouped together (thus stressing the structural similarity between *Lodoicea maldivica* and the more widespread *Phoenicophorium borsigianum*, *Nephrosperma vanhouetteana*, *Vershaeffelia splendida* and *Roscheria melanochaetes*) the Vallée de Mai site can be added into the palm derived habitats (44-47). The remainder of the group are united by the presence of *Clidemia hirta*, exclusion of this species retains the grouping but moves it to the high forest habitats. Two other sites appear to be anomalously placed. The *Eucalyptus* plantation (13) is grouped with the lowland habitats (14-19) due to its open structure, as is the suburban site (20) within the open high altitude (21-24) grouping. Neither of these are included on the basis of shared taxa and should be removed from their groupings.

Fig. 1. Islands studied with field sites marked.



Beoliere: *Dracaena* 360 (60%); *Canthium bibracteatum* 200 (33%). Diversity=1.53; native 1.57, alien 0.15.

4. **Casuarina habitat** - *Casuarina equisetifolia* forming >50% of trees.

Casuarina plantations closely resemble natural *Casuarina* habitat on coastal sandy soil, although tree density is un-naturally high. This habitat is slowly invaded by other species; *Alstonia macrophylla* frequent on Mahé, *Calophyllum inophyllum* and *Terminalia catappa* are the most widespread colonists.

Coral mountain: *Casuarina* 2000 (100%). Diversity=0.

Pt. Ramasse Tout: *Casuarina* 1000 (99%). Diversity=0.29; native 0.29, alien 0.

Casuarina plantation: *Casuarina* 5000 (100%). Diversity=0.

5. **Lowland habitats** - *Terminalia catappa* present at >500/ha

5a. **Mangroves** - >50% mangrove species.

Mangrove forests are stable in the short term, with very little invasion in the waterlogged muds. Mangrove roots trap sediments and lead to the formation of banks in the marshes. As these accumulate and dry they are colonised by other species. The commonest are *Calophyllum inophyllum* and *Terminalia catappa*. *Heritiera littoralis* is also abundant. The species composition of the mangroves varies with location.

Curieuse: *Avicennia* 2960 (39%); *Calophyllum* 2400 (30%); *Terminalia* 1580 (13%); *Cocos* 720 (9%); *Lumnitzera* 680 (8%). Diversity=0.42; native 0.42, alien 0

5b. **Calophyllum-Terminalia forest** - *Terminalia catappa* >50% & *Calophyllum inophyllum* >30%.

This typical lowland forest type is developed from marshy ground (as in succession from mangroves) or in flood areas where seed is dispersed by flood waters. It is usually mixed with *Heritiera littoralis* being an important natural component. This habitat is present in the main areas of development and consequently have high invasion by alien species (planted and escapes). The characteristic *Calophyllum-Terminalia* forest found on La Digue is a secondary habitat and represents a low diversity transitional stage in the development of coastal mixed forest (5c). In drier areas *T. catappa* is rare or absent, the main species in this form at *C. inophyllum* with significant numbers of *Mimusops sechellarum*, *Deckenia nobilis* and *Pandanus* spp. Pristine areas of this habitat have been found at Coco dans Trou and La Reserve (Silhouette).

La Digue: *Terminalia* 1200 (59%); *Calophyllum* 800 (38%). Diversity=0.49; native 0.49, alien 0

5c. **Mixed** - no one species or combination forming more than 80% (with the exception of planted coconuts, *Cocos nucifera*), *Terminalia* & *Calophyllum* abundant (>500 & >300 per ha. respectively). Includes rocky valleys with abundant *Barringtonia racemosa* and *Heritiera littoralis* (e.g. Anse Mondon and Riviere Machabee, Silhouette). Many areas heavily invaded or are secondary forest (characterised by alien species forming >25%).

Beau Vallon: *Terminalia* 1200 (40%); *Calophyllum* 400 (13%); *Heritiera* 500 (17%); *Cocos* 300 (10%). Diversity=0.67; native 0.47, alien 0.29.

Grande Barbe: *Terminalia catappa* 1000 (40%), *Calophyllum inophyllum* 750 (30%), *Cocos nucifera* 300 (12%), *Tabebuia pallida* 200 (8%). Diversity 0.52; native 0.50, alien 0.

Anse Mondon: *Barringtonia racemosa* 3000 (60%), *Heritiera littoralis* 800 (16%), *Terminalia catappa* 600 (12%), *Calophyllum inophyllum* 300 (6%), *Cocos nucifera* 800 (15%). Diversity 1.05; native 1.25, alien 0.17.

La Passe: *Cocos nucifera* 4000 (79%), *Terminalia catappa* 500 (9%), *Calophyllum inophyllum* 300 (5%), *Tabebuia pallida* 200 (5%). Diversity=1.11; native 1.01, alien 0.45.

6. **Suburb** - trees restricted to areas of garden, buildings <50m apart.

Suburb: *Cinnamomum verum* 1000 (67%); *Manguifera indica* 240 (8%). Diversity=0.28; native 0, alien 0.28

7. **Open high altitude** - open canopy, vegetated, >400m above sea-level.

7a. **Mixed** (*Clidemia hirta* habitats) - heavy *C. hirta* invasion (200/ha.).

The changes in *Clidemia hirta* dominated mixed open high altitude habitat are discussed in full detail in Gerlach 1996. The coffee (*Coffea canephora*) plantation at Mare aux Cochons is a typical plantation habitat in its origins and total domination by one plant species. The very wet nature of the site results in the site being colonised by a small number of species characteristic of mixed open high altitude forest. Following abandonment of this site the trees have grown rapidly, seeding in profusion, resulting in very dense vegetation (increases from 0.25m^{-2} to 3.4m^{-2} have been recorded in a 5 year period).

Mare aux Cochons: *Coffea* 34000 (99%). Diversity=0.05; native 0, alien 0

Mont Dauban: *Roscheria* 1200 (39%), *Northea* 1600 (35%), *Cinnamomum verum* 800 (14%), *Phoenicophorium* 400 (7%), *Clidemia* 400 (7%), *Dillenia ferruginea* 400 (7%), *Glionettia* 800 (7%), *Pandanus seychellarum* 400 (7%). Diversity=1.11; native 1.01, alien 0.45.

Mon Plaisir: *Cinnamomum verum* 1200 (48%), *Psidium cattleianum* 1100 (44%), *Clidemia* 200 (8%). Diversity=0.10; native 0.02, alien 0.52.

7b. ***Pisonia sechellarum* forest** - characterised by *P. sechellarum* presence

Species present: *Pisonia sechellarum* 400 (73%); *Dracaena* 66 (12%); *Cinnamomum verum* 27 (5%). Diversity=0.51; native 0.44, alien 0.30.

7c. ***Cyathea scrub*** - *Cyathea sechellarum* abundant (>4000/ha.).

Cyathea - Mt. Pot a Eau: *Cyathea* 6000 (60%); *Angiopteris* 4000 (40%). Diversity=0.11; native 0.11, alien 0.

Cyathea - Mt. Dauban: *Cyathea* 4500 (100%). Diversity=0.10; native 0.10, alien 0.

Cyathea - Morne Seychellois: *Cyathea* 4000 (98%). Diversity=0.10; native 0.10, alien 0.

8. Dry scrub - trees restricted to isolated pockets. <200m above sea level.

8a. Open - extensive areas of bare rock

Mt. Poules Marrons: *Anacardium* 160 (28%), *Phoenicophorium* 120 (20%), *Calophyllum* 120 (20%), *Intsia* 80 (13%), *Pandanus balfouri* 80 (13%), *Terminalia* 40 (6%). Diversity=0.30; native 0, alien 0

8b. Closed - *Memecylon floribundum* or *Tabebuia pallida* >2000/ha.

Memecylon floribundum: *Memecylon floribundum* 74750 (98%). Diversity=0.07; native 0, alien 0.06.

Tabebuia pallida forest: *Tabebuia pallida* 20000 (80%), *Cinnamomum verum* 1500 (6%). Diversity=0.30; native 0, alien 0.30.

9. Invaded high altitude forest - aliens forming >80%

9a. Old plantations - as 2. But with invasion by other species and regeneration of natives. At least one alien species other than *Cinnamomum verum* >40%.

Riviere Bois de Fer: *Sandorcum* 3000 (47%); *Cinnamomum verum* 1480 (23%); *Hevea* 560 (9%); *Pterocarpus* 400 (6%). Diversity=0.64; native 0.18, alien 0.58.

Hevea plantation: *Hevea* 1440 (67%); *Phoenicophorium*, 240 (11%); *Cocos* 240 (11%). Diversity=0.50; native 0.29, alien 0.39.

9b. *Cinnamomum verum* forest - old plantations or areas with heavy *C. verum* invasion (>40%).

Trois Freres: *Cinnamomum verum* 5360 (89%); *Paraserianthes* 400 (8%); *Cerbera* 280 (5%); *Memecylon floribundum* 280 (5%); *Chrysobalanus* 240 (5%). Diversity=0.50; native 0.29, alien 0.39.

Morne Blanc: *Syzygium jambos* 20000 (47%); *Cinnamomum verum* 17600 (41%). Diversity=0.55; native 0.80, alien 0.36.

Riverine: *Cinnamomum verum* 2000 (56%); *Dillenia ferruginea* 400 (22%); *Phoenicophorium* 400 (22%). Diversity=0.58; native 0.30, alien 0.47.

Le Niol: *Cinnamomum verum* 3085 (53%); *Chrysobalanus* 1028 (17%); *Phoenicophorium* 571 (10%); *Pentadesma* 457 (8%).

Diversity=0.70; native 0.29, alien 0.64.

9c. *Chrysobalanus icaco* scrubby forest - invaded by *C. icaco* (to 3600/ha.).

La Reserve mahogany: *Chrysobalanus* 8000 (50%), *Cinnamomum verum* 6000 (38%), *Swietenia* 2000 (11%). Diversity=0.49; native 0, alien 0.49

Chrysobalanus - Le Niol: *Chrysobalanus* 16000 (98%). Diversity 0.02; native 0, alien 0.

Chrysobalanus - Beoliere: *Chrysobalanus* 10000 (95%), *Phoenicophorium* 500 (5%). Diversity=0.19; native 0.57, alien 0.09.

9d. Mixed forest - no one species forming more than 25%, aliens >50%.

Forest at Le Niol: *Cinnamomum verum* 1250 (25%), *Phoenicophorium* 1000 (20%), *Tabebuia pallida* 500 (10%), *Alstonia* 250 (5%). *Calophyllum* 1000 (20%), *Cocos* 250 (5%), *Memecylon floribundum* 250 (5%), *Nephrosperma* 250 (5%). Diversity=0.55; native 0.32, alien 0.47.

Baie Cipailles: *Calophyllum* 1250 (25%), *Cocos* 1250 (25%), *Phoenicophorium* 1250 (25%), *Nephrosperma* 1000 (20%), *Cinnamomum verum* 750 (15%), *Tabebuia pallida* 750 (15%). Diversity=0.75; native 0.54, alien 0.51.

10. High forest - >300m above seal level, aliens forming <60%.

10a. Dry high forest - formed on shallow soils or in soil pockets in glacia areas. This is a very dry habitat with a xerophytic flora. It may also form on eroded fire prone slopes where a natural successional process would lead to conversion to closed high forest. These areas are subject to frequent fires and remain dry. Includes forest patches within glacia areas and *Dicranopteris* invaded burnt slopes, both are colonised by high altitude xerophytic trees, leading to closed forest where soils are sufficient. Some pockets of dry high forest in burnt areas are isolated and relatively inaccessible, these may preserve easily overlooked rare species (e.g. *Bakerella clavata* above Grande Barbe on Silhouette; pers. obs.).

Copolia: *Cinnamomum verum* 740 (49%), *Dillenia ferruginea* 180 (12%). Diversity=0.87; native 0.52, alien 0.79.

Mont Sebert glacia: *Nephrosperma* 2000 (33%), *Pandanus multispicatus* 2000 (33%), *Soulamea* 1600 (25%), *Erythroxylum* 400 (7%). Diversity=0.55; native 0.80, alien 0.36.

10b. Closed high forest - >350m, complete canopy.

10bi. Mossy montane forest - *Roscheria melanochaetes* >480/ha.

Species present: Congo Rouge: *Cinnamomum verum* 1320 (32%); *Northea hornei* 920 (23%); *Roscheria* 480 (12%); *Phoenicophorium* 400 (10%); *Pandanus seychellarum* 280 (7%); *Psidium cattleianum* 280 (7%). Diversity=0.72; native 0.57, alien 0.20.

Jardin Marron high: *Northea hornei* 1600 (33%); *Roscheria* 1200 (25%); *Cinnamomum verum* 800 (17%); *Dillenia ferruginea* 400 (8%); *Pandanus seychellarum* 400 (8%); *Phoenicophorium* 400 (8%). Diversity=0.90; native 0.41, alien 0.78.

10bii. Palm habitats - palms >30% and *Versaffeltia splendida* >36/ha.

Palm forest appear to be vulnerable to invasion by non-palm species. This is most apparent in small patches of palm forest (50m² of *Phoenicophorium borsigianum* at Congo Rouge was replaced *Psidium cattleianum* over a 5 year period). Replacement of larger areas by both invasive and native non-palm species can also be detected, suggesting that palm forest is a transitional stage retained by the its dry, fire-prone nature.

10biia. True palm forest - palms >50% of trees

Vallée de Mai: *Lodoicea* 945 (59%); *Phoenicophorium* 145 (9%); *Psidium cattleianum* 145 (9%); *Pandanus hornei* 109 (7%). Diversity=0.6; native 0.35, alien 0.

La Reserve: *Phoenicophorium* 930 (47%); *Deckenia* 530 (27%); *Nephrosperma* 270 (14%). Diversity=0.64; native 0.58, alien 0.

10biib. Palm rich forests - palms <50% of trees.

Source of Grande Riviere: *Phoenicophorium* 1400 (21%); *Cinnamomum verum* 1200 (18%); *Hevea* 1200 (18%); *Paraserianthes* 800 (12%); *Lodoicea* 400 (9%); *Cola* 400 (6%); *Verschaffeltia* 400 (6%). Diversity 0.80; native 0.42, alien 0.66.

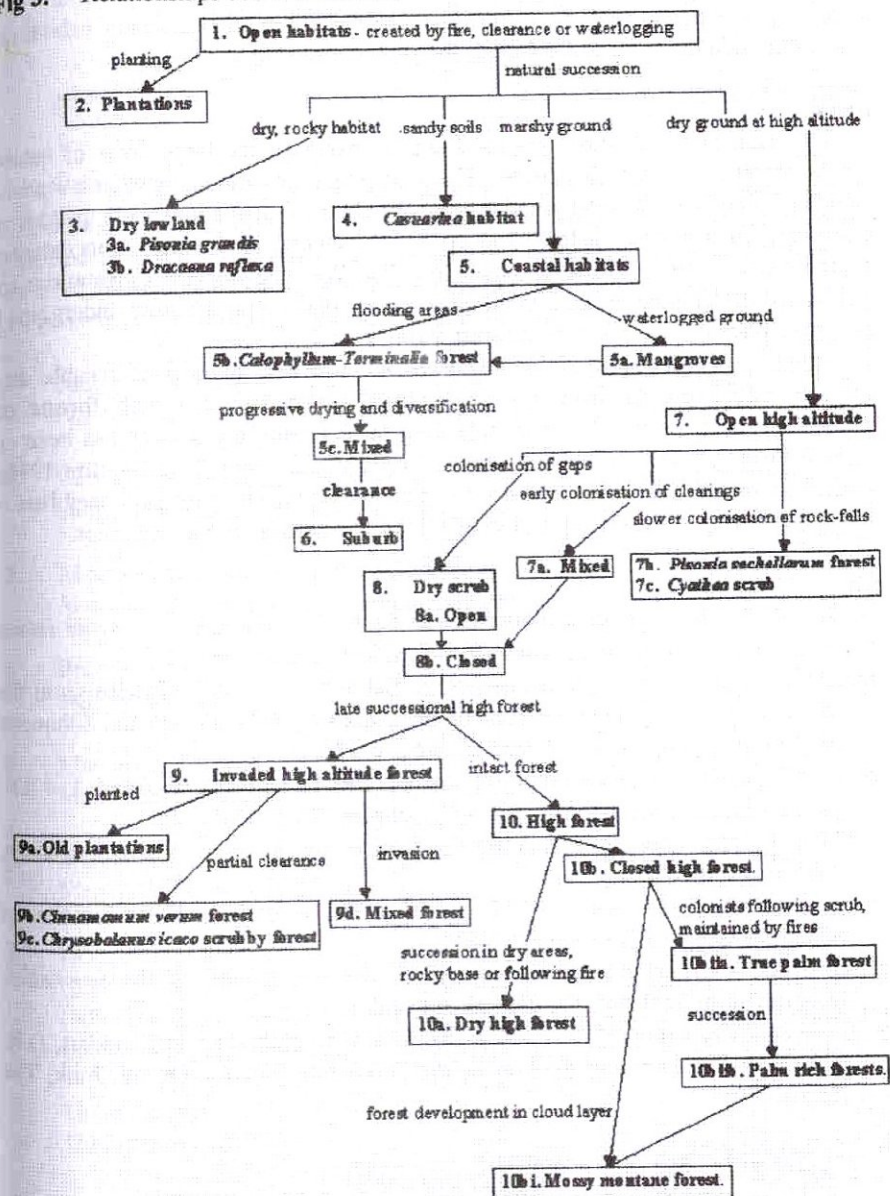
Jardin Marron: *Psidium cattleianum* 1400 (22%); *Artocarpus heterophyllus* 1200 (19%); *Cinnamomum verum* 1000 (16%); *Phoenicophorium* 800 (13%); *Verschaffeltia* 800 (13%); *Roscheria* 600 (9%). Diversity=0.90; native 0.41, alien 0.78.

Evolution of the habitats

The treatment of habitat data as phylogenetic data allows the habitat classification to be interpreted in the light of a hypothetical succession, analogous to an evolutionary process. This 'evolution' of the habitats starts with the open, low diversity habitats. A process of colonisation leads to increased diversity. In dry soils early colonisation is predominantly by *Casuarina equisetifolia* which grows on extremely poor soil where few other species can grow. A ground layer of sedges and *Phyla nodiflora* colonized and the habitat gradually accumulates a litter high in chemicals which appear to inhibit many other plants. Invasion of this habitat is slow until the *Casuarina* trees reach a height at which they become unstable, the gaps created by falling trees are then open to colonists of other species. On rocky slopes vegetation remains relatively low in diversity (with microclimatic exceptions, e.g. *Dracaena* forest). A greater tree density and diversity develops in the coastal habitats where more water is available and a continuing pattern of increased diversity is apparent until closed forest habitats are reached. Forest degradation tends to lead to a reduction in diversity, this is most apparent in suburban habitats where the diversity of ornamental shrubs may be high but very few tree species are retained.

The relationships between all the Seychelles habitats (with the possible exceptions of permanently waterlogged and rocky sites) are dynamic. The general increase in diversity in forest development follows a basic 'succession' but at each stage disturbances or changes are relatively frequent. Rock and tree falls are a frequent feature of the steep hillsides, these result in localised gaps which are colonised by the pioneer species characteristic of the open high altitude and dry scrub habitats. Fire has a similar effect and although less frequent than tree and rock falls affects larger areas. Repeated burning may account for the persistence of large areas of palm habitats on Praslin where-

Fig 3. Relationships between habitats



as such habitat is rapidly converted into closed high altitude forest on Mahé and Silhouette. Such dynamic changes require that large areas of high diversity habitat are preserved to provide the source of colonists for gaps or fire slopes.

Discussion

The habitat classification proposed above covers all the large areas of habitat found in the granitic islands of Seychelles. Coconut plantations are not listed as a separate group despite being an easily recognised habitat. While these plantations were maintained they represented a distinctive habitat that could be included in the plantation category (sharing the planted origin and the extremely low diversity). Few coconut plantations are now maintained in the granitic islands and most former plantations are now undergoing a transition from plantation to low mixed forest forms.

Studies of habitat change in Seychelles are too new to provide reliable data although the available data have previously been summarised for high forests on Silhouette (Gerlach *et al.* 1997). The only long term monitoring project has been on Aride where there are 20 years of data from *Pisonia grandis* woodland (Ayrton 1995), such studies are required for all other habitats. The habitat classification proposed here is intended as a first step in the quantification of habitat characteristics and dynamics.

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Keys to the Seychelles Fauna: 4. Ants

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The following key is for the identification of workers of the ants (Hymenoptera: Formicidae) recorded in Seychelles. The key is based on Hölldobler & Wilson (1990), modified to place emphasis on easily observed features such as coloration. Species recorded from Aldabra or the Amirantes only are marked with an asterisk. Distributions are given only for records not included in Dorow (1996).

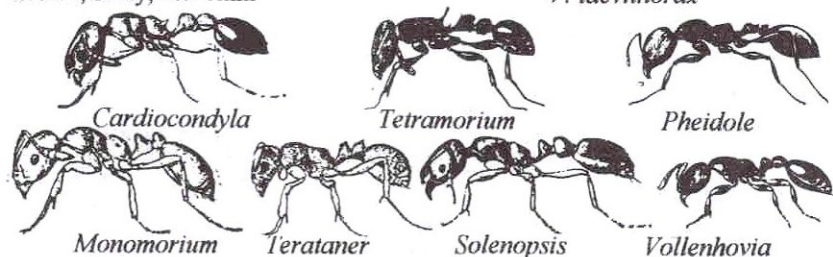
Key:

- | | |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| 1. Pedicel in two parts | 2. (Myrmicinae) |
| Pedicel single | 24. |
| 2. Very elongate, legs relatively short | <i>Tetraponera rufonigra</i> |
| Short bodied to moderately elongate | 3. |
| 3. Abdomen heart-shaped, petiole dorsally attached | 4. (<i>Crematogaster</i>) |
| Abdomen not heart-shaped, petiole normally attached | 5. |
| 4. Brown, 3-4mm | <i>Crematogaster gibba</i> |
| Yellow, 4-6mm | <i>C. ratsoherinae</i> |
| 5. Mandibles elongate, usually linear | 6. (<i>Strumigenys</i>) |
| Mandibles triangular | 8. |
| 6. Mandibles curved | <i>Strumigenys emmae</i> |
| Mandibles linear | 7. |
| 7. Head elongate | <i>Strumigenys scotti</i> |
| Head broad | <i>S. rogeri</i> |
| (NB. There is a doubtful record of <i>S. godeffroyi</i> which is reddish rather than the yellow colour of <i>S. rogeri</i>) | |
| 8. Thorax armed | 9. |
| Thorax unarmed | 13. |

*Tetraponera**Crematogaster**Strumigenys*

NOTES

- | | |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 9. Thorax armed with 2 spines, abdomen dark
Thorax armed with 2-4 spines, uniform colour | <i>Cardiocondyla emeryi</i>
10. (<i>Tetramorium</i>) |
| 10. Woolly appearance, 2 spines
Not woolly, 2-4 spines | <i>Tetramorium lanuginosum</i>
11. |
| 11. 2 spines
4 spines | <i>Tetramorium bicarinatum</i>
12. |
| 12. <3mm, reddish brown to black
3.5-4.5mm, reddish brown | <i>Tetramorium similimum</i>
* <i>T. quadrispinosum</i> |
| 13. Monomorphic, mandibles delicate, 1-6mm
Dimorphic, mandibles powerful, 1-3mm | 14.
20. (<i>Pheidole</i>) |
| 14. Usually <2mm (rarely to 3.5mm), yellow to brown
2-6mm, brown to black | 15. (<i>Monomorium</i>)
18. |
| 15. Brown, 1.5mm
Yellow-brown, 2-3.5mm | <i>Monomorium fossulatum</i>
16. |
| 16. Thorax ridged
Thorax shiny | <i>Monomorium destructor</i>
17. |
| 17. 2mm, head and abdomen brown, thorax yellow
2-2.5mm, uniform colour | <i>Monomorium floricola</i>
* <i>M. pharaonis</i> |
| 18. Pedicel with short spine, black body, 5.5-6mm
Pedicel unarmed, brown to black, 2-6mm | <i>Terataner scotti</i>
19. |
| 19. Red brown, 2.5-3mm
Brown to black, hairy, 2-2.5mm
Brown, shiny, 3.5-6mm | <i>Solenopsis seychellarum</i>
<i>Vollenhovia prioskiae</i>
<i>V. laevithorax</i> |



NOTES

20. Surface rough, 2mm
Surface smooth, 1-3mm
21. Long hairs on body, >2mm
Short, sparse hairs on body, <2mm
22. Spines on thorax, 1-2mm
Thorax unarmed, <1-1.5mm
23. <1mm
1-1.5mm
24. Sting not visible
Sting visible
25. Petiole covered by abdomen
Petiole visible
26. Abdomen light, 4 segments visible dorsally
Abdomen dark, 5 segments visible
27. Narrow abdomen, projecting mandibles
Broad abdomen, short mandibles
28. Pale tarsi, 3mm
Dark tarsi, 2mm
29. Short, broad body & legs, antenna 9 segments
Body & legs long, antenna with 11-12 segments
30. Long legs, slender body, short, round abdomen
Body, legs and abdomen not as above
31. 1-3mm, dull yellow to black
5-7mm, yellow

Pheidole punctulata
21.

Pheidole megacephala
22.

Pheidole flavens
23.

**Pheidole voeltzkowi*
P. braueri

25.
43. (Ponerinae)

26. (Dolichoderinae)
29. (Formicinae)

Tapinoma melanocephala
27. (*Technomyrmex*)

Technomyrmex mayri
28.

Technomyrmex albipes
T. foreli

Brachymyrmex pardemoyi
30.

31.
33.

32. (*Plagiolepis*)
Anoplolepis longipes



Brachymyrmex



Technomyrmex



Tapinoma



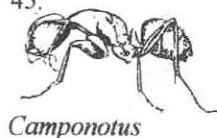
Plagiolepis

Anoplolepis



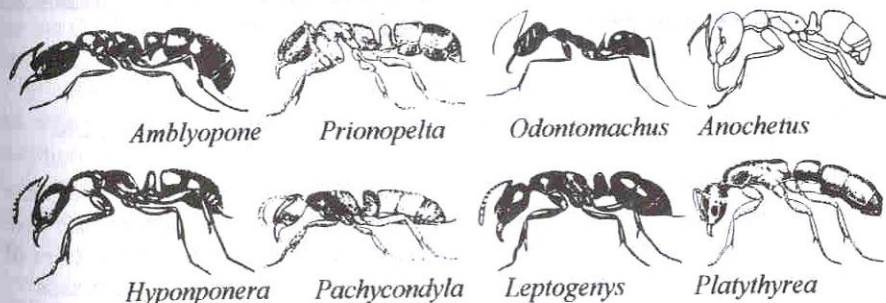
NOTES

- | | |
|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| 32. Dark brown to black
Pale brown with paler antennae and limbs
Dull yellow, head darker | <i>Plagiolepis exigua</i>
<i>P. alluaudi</i>
<i>P. madecassa</i> |
| 33. Slender body, long antennae, abdomen tip projecting
Body, antennae and abdomen not as above | 34. (<i>Paratrechina</i>)
38. (<i>Camponotus</i>) |
| 34. Yellowish
Brownish | <i>Paratrechina bourbonica</i>
35. |
| 35. Distinct blue or violet tint, limbs & antennae paler
No blue tint | <i>Paratrechina longicornis</i>
36. |
| 36. Light brown
Dark brown | 37.
<i>P. madagascariensis</i> |
| 37. 5mm
2-4mm | <i>Paratrechina mixta</i>
* <i>P. steinheili</i> |
| 38. <5mm
>5mm | <i>Camponotus thomasseti</i>
39. |
| 39. Black with pale hairs on abdomen, 6-8mm
Yellow to red-brown, 8-14mm | <i>Camponotus grandidieri</i>
40. |
| 40. Shiny, hairs not apparent
Yellow hairs visible | 41.
* <i>Camponotus auropubens</i> |
| 41. Yellow with reddish head, 6-8mm
Yellow to brown, head yellow or black, 7-14mm | * <i>Camponotus olivieri</i>
<i>C. hova</i> spp. (42.) |
| 42. Yellow-brown, abdomen with dark patches, 8-14mm
Red-brown, abdomen uniform black, 9-10mm
Uniform brown, 7mm | <i>C. h. fulvus</i>
<i>C. h. boivini</i>
* <i>C. h. mixtillus</i> |
| 43. Petiole not distinct from abdomen
Petiole narrowly attached to abdomen | 44.
45. |



NOTES

44. Mandibles elongate, linear, black, >7mm *Amblyopone besucheti*
Mandibles short, triangular, reddish, <2mm *Prionopelta descarpentriresi*
45. Long linear mandibles in middle 46.
Linear or triangular mandibles, at sides 47.
46. Black, >8mm *Odontomachus troglodytes*
Yellow to brown, <8mm *Anochetus madagascariensis*
47. Mandibles elongate, yellow to brown, 1-6mm 48.
Mandibles not elongate, red to black, 3.5-8mm 50.
48. Yellow to pale brown, <5mm, abdomen constricted between segments 1 & 2
49. (*Hypoponera*)
Dark brown with red legs, >5mm, abdomen not constricted, curved down
Pachycondyla melanaria
49. Yellow *Hypoponera ragusai*
Pale brown *H. johannae*
50. Abdomen not elongate, pedicel small, black, >5mm *Leptogenys maxillosa*
Elongate abdomen, broad pedicel, reddish, <5mm *Platythyrea parallela*



Additional distribution records (new island records or first records for 50 years)

Island abbreviations: M = Mahé, C = Cerf, S = Silhouette, P = Praslin

Ponerinae *Odontomachus troglodytes* Santschi, 1914 - S 1996-8; *Pachycondyla melanaria macra* (Emery, 1894) - P 1996; *Prionopelta descarpentriresi* Santschi, 1924 - S 1998

Pseudomyrmecinae *Tetraponera rufonigra* (Jerdon, 1851) - M 1994, S 1997

NOTES

- Myrmicinae *Cardiocondyla emeryi* Forel, 1881 - S 1997; *Crematogaster ratsoherinae* Forel, 1891 - S 1998; *Monomorium destructor* (Jerdon, 1851) - P 1996; *M. floricola* (Jerdon, 1851) - S 1998; *M. fossulatum* Emery, 1894 - S 1998; *Pheidole braueri* Forel, 1897 - S 1997; *Solenopsis seychellarum* Forel, 1909 - M 1996; *Strumigenys emmae* (Emery, 1890) - M 1994-6, S 1997; *S. rogeri* Emery, 1890 - M 1991-2, S 1998; *Tetramorium simillimum* (Smith, 1851) - S 1998; *Vollenhovia laevithorax alluaudi* Emery, 1894 - S 1998; *V. prioskae* Forel, 1912 - S 1997
- Dolichoderinae *Technomyrmex albipes* (Smith, 1861) - C 1996, S 1998; *T. foreli* Emery, 1893 - S 1997-8; *T. mayri* Forel, 1891 - S 1997-8
- Formicinae *Camponotus thomasseti* Forel, 1912 - M 1994, S 1997; *C. grandidieri* Forel, 1886 - S 1998; *C. hova* Forel, 1886; *boivini* Forel, 1891 - M 1996; *C. h. fulvus* Emery, 1894 - S 1998; *Paratrechina bourbonica* (Forel, 1886) - M 1992; *Plagiolepis exigua* Forel, 1894 - S 1998, P 1993-6

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NOTES

New and rediscovered animals in Seychelles

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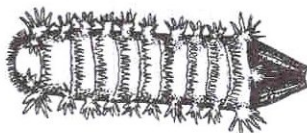
Recent research on Silhouette island has resulted in the discovery of new populations of several invertebrate species. Two of these are distinctive species that were previously known from single specimens collected before 1911 and are rediscoveries of species feared extinct (Gerlach 1997). The third represents a new family for the islands.

DIPLOPODA

Family POLYXENIIDAE

Polyxenus sp.

A species of bristly millipede, *Polyxenus*, was found under the bark of a coconut tree (*Cocos nucifera* L.) at La Passe, Silhouette on 7/2/1998. These wood-inhabiting millipedes are widely distributed but have not previously been found in Seychelles. The specimens



NOTES

(NPTS U1998.4) have not been identified to species to date as there are several very similar taxa.

Family TRIGONIULIDAE

Eucarla urophorus (Pocock, 1893)

E. urophorus was known from a specimen collected at an unknown locality on Mahé (Pocock 1893) and a second specimen, also from Mahé in 1894 (Attems, 1900). In September 1997 a second specimen (NPTS 1997.1) was found under the bark of a rotten log at Jardin Marron, Silhouette. Rotten logs have rarely been investigated and this apparently very rare species may be more widespread and abundant than the present scarcity of records suggests.



LEPIDOPTERA

Family SPHINGIDAE

Cephonodes tamsii Griveaud, 1960

Bee hawkmoths have been recorded in Seychelles on several occasions but appear to be rare or only locally abundant. The African species *C. hylas* Linnaeus, 1771 is widespread but the endemic *C. tamsii* has been recorded only once. The single specimen of this species is a male reared from a larva by H.P. Thomasset in 1911. This appears to have been reared on *Canthium bibracteum* (Baker) Hiern (Legrand 1965).

On 3/7/1997 a green bee hawkmoth, *C. hylas*, flew into the NPTS building at La Passe, Silhouette. 5 days later three were seen feeding on *Lantana camara* L. flowers near the Dauban mausoleum at La Passe at 17:30h. This species was seen regularly in the late afternoon at this site until 18/8/1997 (Table 1.).

On 16/7/1997 a single individual of the distinctive red bee hawkmoth, *C. tamsii*, was seen in the same area. This species was seen again on 14/8/97 and 18/8/97, a maximum of 3 were seen. Both species were feeding on the yellow, unpollinated flowers of *L. camara*. *C. hylas* was also feeding on *Catharanthus roseus* (L.) G. Don and *Asystasia* sp. (the latter for very short periods only). *C. tamsii* was seen both during the morning and afternoon (11:31, 11:47, 11:59, 17:40-44).

Table 1. Number of *Cephonodes* recorded at La Passe

Date	Time	<i>C. hylas</i>	<i>C. tamsii</i>
9/7/97	17:15	1	0
10/7/97	16:45	1	0
12/7/97	17:15	1	0
13/7/97	16:05	1	0
16/7/97	17:40	1	1
20/7/97	17:25	1	0
14/8/97	17:20-44	1	1
16/8/97	17:05	1	0
17/8/97	17:31-29	12	0
18/8/97	11:31-59	9	3

NOTES

The hawkmoths have only been seen in a very restricted area; *C. hylas* in an area of approximately 5,000m² and *C. tamsi* in only 10m². Searches for larvae have been unsuccessful although the recorded food plant for both species, *Canthium bibracteatum* is abundant in the surrounding area. Since the hawkmoths were first seen the site has been visited daily but no hawkmoths were found after 18/8/1997.

Family TINEIIDAE

Trichophaga mormopis Meyrick

This small moth was found in barn owl (*Tyto alba* (Scopoli, 1769), pellets collected on Aride by M. Betts in April 1996. Boxes of pellets opened 3 months after collection contained living spiders, pseudoscorpions and moths. Numerous caterpillars were found feeding on the pellets. In addition there were several pupae and a few emerged moths. Two specimens of the moth were preserved and have been identified as *T. mormopis* by Dr. G.S. Robinson of the British Museum (Natural History). One specimen is in the BM(NH), the other in the collection of The Nature Protection Trust of Seychelles (NPTS HI1998.57).

This is a widespread species with an almost pantropical distribution. It is often found in stored animal fibres or in owl pellets (Robinson *pers. comm.*). It is believed to have been introduced to many countries.

OPILIONES

Family ASAMIIDAE

Bandona palpalis Roewer, 1927

A single opilionid collected from the edge of the Dauban marsh, La Passe. Silhouette on 14/7/1997 was identified by Dra. M. Rambla of Barcelona University as *Bandona palpalis*. This species was described from Chiang Mai Province, Thailand. A second species of the genus, *B. boninensis* Suzuki, 1974, from the Bonin islands may be synonymous with *B. palpalis* (Rambla *pers. comm.*).

Acknowledgements

I am grateful to Dr. G. Robinson and Dra. M. Rambla for their extremely efficient identification of the tineid moth and opilionid respectively.

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NOTES

Editor's note: The following note is an excerpt taken from *La Tortue* 39 (1997). The original French text describes a visit to Aldabra made by the French tortoise conservation organisation SOPTOM, in May 1997. During the visit small scale studies were made into some aspects of giant tortoise biology. In order to draw these studies to the attention of a wider audience we translate excerpts from the text with the authors' permission. Text translated by G. Gerlach.

The forgotten in Aldabra

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Three short studies were undertaken during our stay on Aldabra. One on the presence or absence of the cervical scute by B. Devaux, another on the diet of the tortoises in different areas, by J. Dupré and the third, completely new, on faecal bacteriology by F. Bonin and P. Strohl.

The second study has been followed up by Dr. Perrin of the Ménagerie of the Jardin des Plantes and the third by Philippe Strohl's doctoral thesis on the faecal flora of reptiles at the Ecole Vétérinaire at Lyons. We summarise these studies, which are not fully completed. If you wish for more detailed information, contact SOPTOM.

The Aldabran tortoise has often been compared to those of the Galapagos (*Chelonoidis nigra*), both being large and living in more or less similar conditions, although at two extremes of the planet. What differentiates them is primarily the presence of a cervical scute in *D. elephantina* while *C. nigra* has none. In fact this criterion is not absolute as a small population of tortoises on Aldabra have a complete absence of the cervical scute.

I have personally carried out an assessment of this subject on the atoll, at three sites, Picard, Dune d'Messe and Cinq Cases. One can distinguish the absence of the cervical on the top, therefore a relative absence, and the total absence of the cervical both above and below, therefore identical to the condition in *C. nigra*. For the relative absence, on the top, I counted 19 tortoises out of 352, that is about 5% of the animals lack a cervical. For the total absence, considered by P. Pritchard as the only valid state, there were only 5 cases out of 352, that is 1.8% of the tortoises lack a cervical.

B. Devaux

Feeding was observed "in natura" on Aldabra on three contrasting sites: the Station on Picard Island, Cinq Cases and Dune d'Messe on Grande Terre. Appreciable biotope differences exist on each of these three sites, which leads to differences in the tortoises' diets. The daily cycle is the same on Cinq Cases and Dune d'Messe, but slightly different on Picard... The tortoises mainly eat between 8-9h. and from 16h., until nightfall. Between times they remain in the shade of big leafy trees (*Guetarda speciosa*...) or under

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bushes where available. Otherwise, they shelter in crevices of dead coral. Rain does not seem to worry them, indeed on the contrary they appreciate it and leave their shelter to take advantage of it.

On Picard, it must be taken into consideration that the tortoises were formerly exterminated by the first colonists and were reintroduced from other "islets". These tortoises are almost domesticated and feed exclusively on natural vegetation. It is the only population observed which seems to prefer dry food to green. The tortoises first eat the dry leaves, the dry grass and, only if there is no more dry food around, they go towards fresh leaves and fresh grass. The principal plants eaten are *Pandanus tectorius*, *Casuarina equisetifolia*, *Caparis carilaginea*, *Hedyotis* sp.

At Cinq Cases the animals are smaller than elsewhere on Aldabra. The vegetation is harsh on the edge of the sea, with a low grass (*Sproobolus virginicus*...). Here *Guettarda speciosa* also grows which serves both as food and shelter. The tortoises eat green and dry leaves, but also the buds, the highly scented flowers and the fruits. When the rain beats down the foliage the tortoises rise upon their back legs to eat the lowest leaves. Further inland the species are more diverse. The tortoises feed on low and twisted bushes with dense foliage (*Pemphis acidula*) from small clumps of tall herbs (*Cyperus dubius* or *bigibbosus*...), and from a type of yucca with spiny and sharp leaves which they particularly like (*Lomatophyllum aldabrense*). In the lakes and pools they eat filamentous algae (*Naias graminea*...).

At Dune d'Messe the vegetation is almost identical to that at Cinq Cases, with a coastal band of tortoise turf (*Sproobolus virginicus*). One finds here a very dry grass, sharp and pointed which grows in little dense tufts and of which the tortoises eat particularly the shoots and seeds (*Sclerodactylon macrostachyum*...). The tortoises pass most of the day here resting under the *Guettarda* as at Cinq Cases, but we have also seen some walking on the sand on the beach and digging a hole to lie in. When the temperature seems favourable, between 16-17h., they go into the crevices of dead coral to take more succulent herbs, like *Asystasia*.

Therefore one sees that the feeding conditions for the tortoises are harsh. When looking at the immense coral concretions as far as one can see, one often asks oneself how they find anything to eat. Although the feral goats have been eradicated and no longer compete with them, the tortoises live and die in difficult conditions. Besides, the corpses stay amongst the living tortoises, at the bottom of a crevice, or in the water of a pool, witnesses to the hard life of *D. elephantina* on Aldabra.

Judith Dupré.

The collection of faeces on Aldabra was carried out by Dr. Bonin. The samples came from three *D. elephantina* tortoises, of which one was female and two male. One living at the station on Picard could be in contact with humans. My work, carried out at the Ecole Vétérinaire at Lyons focuses on two aspects: research into Salmonella for my doctoral thesis and a more general study of the faecal flora of these tortoises. The method

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can be replicated in a classical bacteriology laboratory. 15 days separated sample collection and culture which resulted in the elimination of the most sensitive bacteria from the faeces.

We will not describe these methods here, but these are the results. The research on *Salmonella* was positive and will be present in my doctoral thesis.

The main floral study concerned GRAM negative and GRAM positive bacteria. We have only considered bacteria of which the API plaques give at least "a good identification". Given that these levels of identification are designed for human medicine and that the tortoises studied are exotic we cannot discriminate between acceptable, doubtful or poor identifications.

We have classed the bacteria by tortoise. We note that the three animals carry haemolytic bacilli and invasive *Proteus* (*P. vulgaris*, *P. mirabilis*) which are difficult to culture from our material and which we have not isolated. The GRAM negative bacteria were, for tortoise No. 1: with Oxydase API 20E: *Escherichia coli*, *Citrobacter freundii*, with Oxydase API 20NE: *Aeromonas sobria*, *Aeromonas hydrocaviae*, *Pseudomonas stutzeri*. For tortoise No. 2: with API 20E: *Escherichia coli*, *Citrobacter freundii*, with API 20NE: *Aeromonas hydrocaviae*, *Xanthomonas maltophilia*. For tortoise No. 3: with API 20E: *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter* spp., *Citrobacter freundii*, *Salmonella* spp., with API 20NE: *Pseudomonas* spp., *Pseudomonas vesicularis*, *Acinetobacter* spp., *Flavobacterium breve*.

For the GRAM positive bacteria we have only obtained reliable identification for two strains. Again it is necessary to be cautious with the results because the APILAB system indicates that several biochemical tests are needed to confirm identification. We note for tortoise No. 1, with API 20-Coryne, *Listeria* spp. (found in 2 tests), for tortoise No. 2. nothing, for tortoise No. 3, *Rhodococcus equi* (found in 3 tests).

Our conclusion is that producing evidence of GRAM positive bacteria has been very difficult and the results are questionable. The GRAM negatives profiles of tortoises 1 and 2 are very different from those of tortoise 3. This tortoise lives close to the settlement on Picard. One can therefore imagine human contamination, directly or indirectly (domestic animals). It is always necessary to be prudent as the samples were 15 days old and had transported by air. Furthermore, the small number obscures any statistical differences. In summary, this work could give some information on the "normal" faecal flora of the tortoises of Aldabra, but should be repeated, with a greater number of samples, in better conditions.

Philippe Strohl

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Additions and corrections to the Silhouette species list

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The Silhouette species list published in 1997 (Gerlach *et al.* 1997) included 1567 species. Over the last year a number of overlooked and new records have come to light. These corrections and additions are noted below. This 6% increase brings the total number of species recorded on the island to 1667 (see Table 1.)

PLANTAE

ANGIOSPERMAE

Family ANONACEAE *Annona squamosa* L. - Intr.; Sil. (*pers.obs.*). *Cananga odorata* (Lam.) Hook.f.&Thoms. - Intr.; Sil. (*pers.obs.*)

Family POLYGONACEAE *Antigonon leptopus* Hook.&Arn. - Intr.; Sil. (*pers. obs.*)

Family CAESALPINIACEAE *Senna occidentalis* (L.) Link - Intr.; Sil. (NPTS P1998.2)

Family EUPHORBIACEAE *Acalypha indica* L. - Intr.; Sil. (NPTS P1997.53)

Family UMBELLIFERAE *Centenella asiatica* (L.) Urb. - Intr.; Sil. (*pers. obs.*)

Family CONVULVULACEAE *Ipomoea obscura* (L.) Ker Gawl. - Intr.; Sil. (*pers. obs.*)

Family OLEACEAE *Norohnia emarginata* (Lam.) Thouars - Intr.; Sil. (*pers. obs.*)

Family ACANTHACEAE *Thunbergia grandiflora* (Roxb.&Rottl.) Roxb. - Intr.; Sil. (*pers. obs.*)

Family COMPOSITAE *Emilia sonchifolia* (L.) Wight - Intr.; Sil. (NPTS P1998.1).

Family ZIGIBERACEAE *Aframomum angustifolium* (Sonn.) K.Schum. - Mad.; M. & Sil. (Gerlach *et al.* 1997 as *Elettaria cardamomum*)

Family MARANTACEAE *Maranta arundinacea* L. - Intr.; Sil. (*pers. obs.*)

Family AMARYLLIDACEAE *Crinum amabile* Ker-Gawl. - Intr.; Sil. (*pers.obs.*).
Zephyranthes rosea Lindl. - Intr.; M & Sil. (*pers.obs.*)

Family LILIACEAE *Gloriosa superba* L. - Intr.; Sil. (*pers. obs.*)

Family PALMAE *Dictyospermum album* (Bory) Balf.f. - Intr.; M. & Sil. (*pers. obs.*)

Family CYPERACEAE *Cyperus alopecuroides* Rottb. - Afr.; M., Sil. (NPTS P1997.58), A. & Co.

Family POACEAE *Rhynchelytrum repens* (Willd.) C.E.Hubb. - Intr.?, M., Sil. (NPTS P1997.3) & Den.

ANIMALIA

PLATYHELINTHES Family OTHEOSOMIDAE ?sp. - Sil(NPTS V1998.1)

MOLLUSCA

Family ELOBIIDAE *Melampus cf. fasciatus* - Indo-Pacific; Sil. (NPTS M1997.234).

M. lividus Deshayes - Indo-Pacific; M., Moy., Sil.(NPTS M1997.233), P. & A.

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Table 1. Terrestrial & freshwater species recorded on Silhouette

Group			Species		% natives endemic to	
			Total	Native	Seychelles	Silhouette
PLANTAE	Bryophyta		18	18?	17	6
	Pteridophyta		52	52	19	2
	Angiospermae		212	176	34	2
ANIMALIA	Nemertea		1	1	0	0
	Platyhelminthes		1	1?	100?	0?
	Annelida	Hirudinea	2	2	100	100
		Oligochaeta	1	0?	0	0
	Mollusca		40	36	72	19
	Tardigrada		2	2	0	0
	Chelicerata	Schizomida	1	1	100	0
		Arachnida	81	81	75	23
		Opiliones	9	9	89	11
		Pseudoscorpiones	4	4	100	0
		Scorpiones	1	1	100	0
		Amblypygi	1	1	0	0
		Acari	13	13	92	69
	Crustacea	Decapoda	12	12	0	0
		Isopoda	13	13	85	8
	Myriapoda	Diplopoda	21	18	94	0
		Chilopoda	8	8	75	13
		Symphyla	1	1	?	?
	Apterygota	Thysanura	6	6	100	0
		Collembola	7	7	100	0
	Insecta	Odonata	12	12	33	17
		Orthoptera	37	36	80	15
		Dictyoptera	18	17	71	6
		Isoptera	2	2	100	50
		Dermaptera	13	9	44	22
		Hemiptera	123	123?	72	18
		Psocoptera	64	64?	97	9
		Thysanoptera	11	11	100	89
		Siphonaptera	1	0	0	0
		Neuroptera	3	3	0	0
		Lepidoptera	210	205	54	9
		Trichoptera	1	1	100	0
		Diptera	94	94?	68	61
		Hymenoptera	124	117	79	30
		Coleoptera	390	386	72	18
	Chordata	Pisces	5	4	25	0
		Amphibia	12	12	92	0
		Reptilia	17	14	93	0
		Aves	17	15	40	0
		Mammalia	5	2	100	0

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Family SUBULINIDAE *Allopeas mauritianus* Cosmo; M & Sil (NPTS M1997.239).

CRUSTACEA

Family COENOBITIDAE *Coenobita perlatus* (Milne Edwards, 1837) - Indo-Pacific; Sil (photographed 8/8/97) & A.

Family OCYPODIDAE *Ocypode cordimana* (Desmarest, 1825) - Indo-Pacific; M., Sil (NPTS D1997.31), Co., A. & Bird.

TARDIGRDA

Macrobiotus madegassus Maucci, 1993 - Mad.; Sil. (Biserov & Gerlach 1998) & LD.

Milnesium tetralamellatum Pilato & Binda, 1991 - Afr.; M. & Sil. (Biserov & Gerlach 1998).

OPILIONES

Family ASSAMIIDAE *Bandona palpalis* Roewer, 1927 - Asia; Sil. (Gerlach 1998)

ARACHNIDA

Family OCHYRO CERATIDAE *Ouette ouette* Saarsito, 1998 - End.; Sil. (Saaristo 1998).

MYRIAPODA - DIPLOPODA

Family POLYXENIIDAE *Polyxenus* sp. - ?; Sil. (NPTS U1997.4)

Family HIRUDISOMIDAE *Rhinotus purpureus* (Pocock, 1894) - Intr.; M., Sil (Golovatch & Korsós 1992). *R. densepilosus* Golovatch & Korsós 1992 - End.; M. & Sil. (Golovatch & Korsós 1992).

Family SPIROBOLELLIDAE *Paraspiroboles dictyonus* (Latzel, 1895) - Intro.; M., Sil (Golovatch & Korsós 1992).

Family TRIGONIULIDAE *Eucarlia urophorus* (Pocock, 1893) - End., Sil. (NPTS U1997.9)

APTERYGOTA - COLLEMBOLA

Family NEANURIDAE *Blasconura* sp. - ?; Sil. (L. Deharveng pers. comm.)

INSECTA

ODONATA

Family AESCHNIDAE *Anax guttatus* (Burm., 1839) - Asia; M., Sil. (Wain & Wain 1998; NPTS O1998.1) & A.

ORTHOPTERA

Family ACRYDIIDAE *Paratettys histicus* Sahl - Afr.; M., Sil. (NPTS Hr1998.1) & Fel.

Family GRYLLIDAE *Gryllotalpa africanus* - Afr.; M. & Sil. (P. Matyot pers. obs.). *Trigonidium bolivari* - End.; M. & Sil. (Bolivar, 1912 & Gerlach et al. 1997 as *T. vittaticolle*). *T. vittaticolle* - Intr.; M. & Sil. (NPTS Hr1998.2).

Family PHASGONURIDAE *Conocephalus conocephalus* - Afr.; M. & Sil. (NPTS Hr1998.4).

DERMAPTERA

Family LABIIDAE *Labia minor* (Linnaeus) - Cosmo.; Sil. (NPTS Hw1998.3) & LD.

HEMIPTERA

Family MEMBRACIDAE *Leptocentrus madli* Boulard, 1995 - End.; M. & Sil. (P. Matyot pers. obs.).

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COLEOPTERA

Family BUPRESTIDAE *Dicercomorpha alluaudi* Kerremans, 1893 - M., Sil. (NPTS Hc1998.13) & LD.

Family COLYDIIDAE *Mecedanum* sp. - ?; Sil. (Grouvelle 1918)

Family CORYLOPHIDAE *Arthrolips* sp. - ?; Sil. (Scott 1917)

LEPIDOPTERA

Family GELECHIDAE *Gelechias saffranella* Legrand, 1965 - End.; M. & Sil. (NPTS H11998.52).

Family GEOMETRIDAE *Chloroclystis gerberae* Herb., 1964 - End; M & Sil (*pers. obs.*).
C. mokenis Prout, 1937 - Afr; M & Sil (NPTS H11998.10). *C. oceanica* Herb., 1964 - End; M & Sil (NPTS H11998.45). *Scopula serena* Prout, 1920 - Afr; M & Sil (*pers. obs.*).

Family HELIODINIDAE *Stathmopoda auriferella* (Walker, 1864) - Afr.; M. & Sil. (*pers. obs.*).

Family LITHOCOLLETIDAE *Acrocercops rhombocosma* Meyrick, 1911 - End.; M. & Sil. (NPTS H11998.19). *Caloptila prostricta* (Meyrick, 1909) - Afr.; M. & Sil. (NPTS H11998.44).

Family LYONETIDAE *Opogona tabernatella* Legrand, 1965 - End.; M. & Sil. (NPTS H11998.29)

Family NOCTUIDAE *Achaea catella* Guenée, 1852 - Afr.; M. & Sil. (*pers. obs.*).
Hydrillodes perplexalis Fryer, 1912 - End.; M., Sil. (*pers. obs.*) & P. *Hypaetia extranea* Berio, 1962 - End.; M. & Sil. (*pers. obs.*) *Hypospyla thermesina* Guenée, 1865 - Masc.; M., Sil. (NPTS H11998.25) & Fel. *Leucania leucosphendoides* Berio, 1956 - End.; M. & Sil. (NPTS H11998.3). *Mocis meyeri* (Boiduval, 1833) - Afr.; M., SA., Sil. (NPTS H11998.23&56) & P. *Spodoptera mauritia* (Bosiduval, 1833) - Mad.; M., Sil. (NPTS H11998.2&54) & F.

Family PHYCITIDAE *Phycita gloriosella* Legrand, 1965 - End.; M. & Sil (*pers. obs.*).

Family PTEROPHORIDAE *Megalorrhypida defectalis* (Walker, 1864) - Pantrop.; M. & Sil. (NPTS H11998.42).

Family PYRALIDAE *Cirrhocrista mullerensis* Legrand, 1957 - End.; M., Sil. (NPTS H11998.39) & P.

Family PYRAUSTIDAE *Diaphana prasinalis* (Saalmuller, 1880) - Mad.; M. & Sil. (NPTS H11998.8&55), *Epipagis cancellalis* (Zeller, 1852) - Old World; M. & Sil. (NPTS H11998.9). *Hedylepta dnopheralis* (Mabille, 1900) - Mad.; M. & Sil. (NPTS 1998.11). *Psara basalis* (Walker, 1865) - Old World; M. & Sil. (*pers. obs.*).
Zebonia mariahelena Legrand, 1965 - End.; M. & Sil. (*pers. obs.*).

Family SPHINGIDAE *Cephonodes tamsi* Griveaud, 1960 - End.; M. & Sil. (NPTS H11997.7)

Family TINEIDAE *Nitidea fuscipunctella* (Haworth, 1828) - Introduced; M. & Sil. (NPTS H11998.25). *Steomorpha rutella* Zeller, 1852 - Pantrop.; M. & Sil. (NPTS H11998.36).

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Family TORTRICIDAE *Eccopsis incultana* (Walker, 1863) - Afr.; M. & Sil. (NPTS HI1998.26)

HYMENOPTERA

Family SPHECIDAE (incl. Sphegidae) *Chalybion madecassum* (Gribodo, 1883) - Mad.; M., Sil. (Madl *et al.* 1996). & P. *Sceliphron fuscum* (Klug, 1801) - Mad.; M., Sil. (Madl *et al.* 1996) & P. *Sphex rufinervis* Perez, 1895 - End.; M., Sil. (Madl *et al.* 1996) & P. *Liris haemorrhoidalis* - Mad.; M. & Sil. (Madl *et al.* 1996).

Family FORMICIDAE *Monomorium floricola* (Jerdon, 1851) - Intr.; M., Sil. (NPTS Hy1998.6), P., A., Co., CS., Alb., GS. & PS. *Odontomachus troglodytes* Santschi, 1914 - Afr.; M., Isl., Sil. (NPTS Hy1998.19), P., Co., Coe., CS., GS., & PS. *Pheidole braueri* Forel, 1897 - End.; Sil. (*pers. obs.*). *Plagiolepis exigua* Forel, 1894 - Pantrop.; M., Sil. (NPTS Hy1998.11), P., A., GS. & PS. *Prionopelta descarpentriese* Santschi, 1924 - Mad.; Sil. (NPTS Hy1998.14) & PS. *Strumigenys emmae* (Emery, 1890) - Intr.; M., Sil. (*pers. obs.*), GS. & PS. *S. rogeri* Emery, 1890 - Intr.; M., Sil. (NPTS Hy1998.8-9) & Co. *Technomyrmex mayri* Forel, 1891 - Mad.; M. & Sil. (NPTS Hy1998.16). *Tetramorium simillimum* (Smith, 1851) - Pantrop.; M., Sil. (NPTS Hy1998.10&12), A., GS. & PS.

CHORDATA

REPTILIA

Family GEKKONIDAE *Ailuronyx tachyscopaeus* Gerlach & Canning, 1994 - End.; M., Sil. (NPTS Cr1998.5) & P.

Family TYPHLOPIDAE *Rhamphotyphlops brahminus* (Daudin) - Intr.; M., Sil. (photographed 7/97), P., A., LD. & F.

AVES

Family ARDEIDAE *Nycticorax nycticorax* (L., 1758) - Cosmo.; Sil. (R. Gerlach in prep.)

MAMMALIA

Family MURIDAE *Mus musculus* (Linnaeus, 1758) - Intr.; M., Sil. (NPTS Cm1997.8), P., A., Freg. & Bird.

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New Records of Seychelles Tardigrades

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Abstract: Three species of tardigrades were recorded from moss samples collected in some islands of the Archipelago, one of which is new to the Seychelles fauna (*Macrobiotus madegassus*). Some inaccuracies in the first description of this species are noted.

Introduction

In two papers concerning the tardigrades from the Seychelles 15 species were recorded. 7 species, including 3 new to science, were reported by Biserov (1994) from Assumption Island and 9 species, including 2 new to science, were reported by Binda & Pilato (1995) from the islands of Mahé and Praslin. Only *Minibiotus intermedius* was found in both studies.

The material examined in the present study consisted of 9 moss samples collected on the islands of Mahé, Praslin, Silhouette, and La Digue. Only two samples (from Silhouette and La Digue) contained tardigrades. 3 species of water bears were identified, one of which is new to the Archipelago's fauna.

Taxonomy

Macrobiotus madegassus Maucci, 1993 (Figs. A-D)

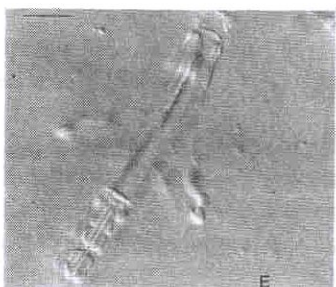
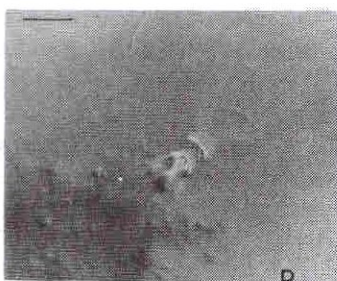
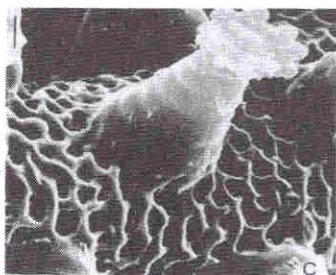
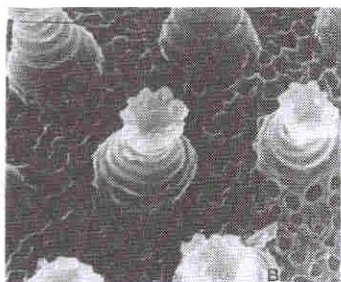
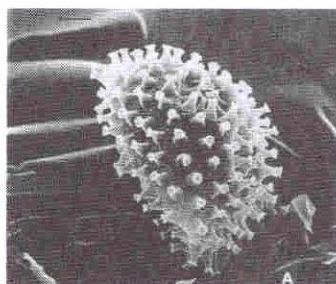
La Digue, a moss sample from *Cocos nucifera* L., 17 specimens and 5 eggs.

Silhouette, a moss sample from breadfruit tree, *Artocarpus altilis* (Parkins.) Fosb., 7 specimens.

Length of body from 180µm to 365µm. Other morphometric data agree well with the description by W. Maucci (1993). There are some errors in the description of the species. Maucci wrote: "...Cuticola: senza pori. L'armature boccale consiste solamente nelle creste trasversali posteriori, senza dentelli." In reality this species has pores on the cuticle (sometimes very difficult to see on some specimens) and the dorsal ridges are joined to one another to form a single transversal ridge. These features can be observed on both the Seychelles specimens and the type series from Madagascar, including the holotype (slides number 14005 and 14009 from Maucci's collection). In comparison to specimens from Madagascar the Seychelles populations have well developed diffuse ocular spots. The old specimens have transverse bands (up to 10) of black pigment on the cuticle.

NOTES

The species is new to the Archipelago's fauna, previously being known from Madagascar, St-Marie Island and the very small Ile aux Nattes only (both latter islands are situated near the east coast of Madagascar).



Figs. A-C, *Macrobiotus madegassus*, eggs, scanning electron microscopy: A - general view, B - detail of egg surface, C - separate process of egg.

Figs. D-F, differential interference contrast. D - *Macrobiotus madegassus*, buccal armature, dorsal aspect. E-F *Macrobiotus seychellensis*: E - buccal armature, dorsal aspect, F - lunules of legs IV.

Scale bars: C = 1 μ m, A, B, D, E, F = 10 μ m.

NOTES

Macrobiotus seychellensis Biserov, 1994 (Figs. E-F)
La Digue, a moss sample from *Cocos nucifera* L., 1 specimen.

We consider this specimen to belonging to *M. seychellensis* rather than to *M. iharosi* Pilato *et al.*, 1991 since the individual has a relatively thick transverse joint ridge in the buccal armature and well developed teeth on the lunules of the hind legs. Unfortunately, the lack of eggs makes precise identification of this specimen impossible. *M. seychellensis* has been reported from Assumption Island only.

Milnesium tetralamellatum Pilato & Binda, 1991.

Silhouette, a moss sample from breadfruit tree, *Artocarpus altilis* (Parkins.) Fosb., 9 specimens. Typical specimens with 4 peribuccal lamellae. For Seychelles Binda & Pilato (1995) reported this species from Mahé Is.

Acknowledgements

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NOTES

Chilocorus nigrinus (Fabricius) (Coleoptera: Coccinellidae) on Cousine Island sixty years after release in Seychelles

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Chilocorus nigrinus is a highly effective biocontrol agent (Samways, 1984) that has been translocated and moved naturally to many climatically suitable parts of the world (Samways 1989).

Forty individuals were introduced into the Seychelles on 28 December 1938 from Coimbatore, India. The beetle was reared and released against the scale insects *Ischnaspis longirostris*, *Pinnaspis buxi* and *Chrysomphalus aonidum* on coconut palm. All three species were reduced by the beetle (Vesey-FitzGerald 1941, 1953).

NOTES

Once an agent has reduced a target, often little attention is paid to it. Yet it is often of interest to know if it is still present. In the case of *Chilocorus nigritus*, it is still in the Seychelles, with three individuals being recorded during the last two weeks of January 1998 on Cousine island. They were free walking and not associated with any particular prey species.

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NOTES

The coral reef fishes of the eastern reef of Cousine Island, Seychelles

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Between 8 January and 10 February 1998, we undertook a total of 30 scuba hours to a depth of 10.5m, plus about 10 snorkelling hours, on the eastern reef ($\pm 800\text{m} \times 30\text{m}$) of Cousine Island. - We recorded the following species of fishes:

- DASYATIDAE** *Rhinoptera javanica* Müller & Henle - Flapnose ray; *Taeniura lymma* (Forsskål) - Bluespotted ribbontail ray;
- CARCHARHINIDAE** *Triaenodon obesus* (Rüppell) - Reef whitetip shark
- MURAENIDAE** *Gymnothorax brederi* (McCosker & Randall) - Masked moray; *Leiuranus semicinctus* (Lay & Bennett) - Saddled snake eel; *Siderea grisea* (Lacépède) - Geometric moray
- HOLOCENTRIDAE** *Neoniphon sammara* (Forsskål) - Bloodspot squirrelfish; *Sargocentron caudimaculatum* (Rüppell) - Tailspot squirrelfish; *S. diadema* (Lacépède) - Crown squirrelfish
- SYNGNATHIDAE** *Choeroichthys sculptus* (Günther) - Sculptured pipefish
- SERRANIDAE** *Cephalopholis argus* (Schneider) - Peacock grouper; *C. miniata* (Forsskål) - Coral hind; *C. sonnerati* (Valenciennes) - Tomatoe grouper; *Epinephelus chlorostigma* (Valenciennes) - Brownspotted grouper; *Plectropomus*

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- laevis* (Lacépède) - Saddleback coral grouper
- CARANGIDAE** *Caranx melampygus* (Cuvier) - Bluefin trevally; *Trachinotus bailloni* (Lacépède) - Small-spotted pompano
- LUTJANIDAE** *Aprion virescens* (Valenciennes) - Green jobfish; *Caesio caeruleaurea* Lacépède - Scissor-tailed fusilier; *C. xanthonota* Bleeker - Yellowtop fusilier; *Lutjanus gibbus* (Forsskål) - Humpback snapper; *L. monostigma* (Cuvier) - One-spot snapper; *Macolor niger* (Forsskål) - Black snapper; *Pterocaesio marri* Schultz - Twinstripe fusilier; *P. tile* (Cuvier) - Bluestreak fusilier
- HAEMULIDAE** *Plectorhinchus vittatus* (Bloch) - Oriental sweetlips
- LETHRINIDAE** *Lethrinus harak* (Forsskål) - Blackspot emperor; *L. microdon* Valenciennes - Smalltooth emperor; *L. nebulosus* (Forsskål) - Spangled emperor
- MULLIDAE** *Mulloidichthys flavolineatus* (Lacépède) - Yellowstripe goatfish; *Parupeneus barberinus* (Lacépède) - Dash-and-dot goatfish; *P. indicus* (Shaw) - Indian goatfish; *P. rubescens* (Lacépède) - Rosy goatfish
- EPHIPPIDAE** *Platax orbicularis* (Forsskål) - Circular spadefish
- CHAETODONTIDAE** *Chaetodon auriga* Forsskål - Threadfin butterflyfish; *C. falcula* Bloch - Saddleback butterflyfish; *C. guttatissimus* - Spotted butterflyfish; *C. lineolatus* Cuvier - Lined butterflyfish; *C. lunula* (Lacépède) - Raccoon butterflyfish; *C. melamnotus* Bloch - Black-backed butterflyfish; *C. trifascialis* (Quoy & Gaimard) - Chevroned butterflyfish; *C. trifasciatus* Park - Redfin butterflyfish; *C. xanthocephalus* Bennet - Yellowhead butterflyfish; *C. zanzibariensis* Playfair - Zanzibar butterflyfish
- POMACANTHIDAE** *Apolemichthys trimaculatus* (Lacépède) - Three-spot angelfish; *Centropyge acanthops* (Norman) - Jumping bean; *Pomacanthus imperator* (Bloch) - Emperor angelfish; *P. semicirculatus* (Cuvier) - Semicircle angelfish
- POMACENTRIDAE** *Abudefduf sexfasciatus* (Lacépède) - Scissor-tail sergeant; *A. vaigiensis* (Quoy & Gaimard) - Indo-Pacific sergeant; *Amphiprion akallopisos* Bleeker - Skunk anemonefish; *A. fuscocaudatus* Allen - Seychelles anemonefish; *Plectroglyphidodon dickii* (Liénard) - Dick's damsel; *P. imparipennis* (Vaillant & Sauvage) - Brighteye damsel; *P. johnstonianus* Fowler & Ball - Johnston damsel; *P. lacrymatus* (Quoy & Gaimard) - Jewel damsel; *Chromis atripectoralis* Welander & Schultz - Black-axil chromis; *C. biocellata* (Quoy & Gaimard) - Twospot demoiselle; *C. dimidiata* (Klunzinger) - Twotone chromis; *Chrysiptera leucopoma* (Lesson) - Surge demoiselle; *C. opercularis* (Günther) - Doublebar chromis; *C. ternatensis* (Bleeker) - Ternate chromis; *C. unimaculata* (Cuvier) - One-spot demoiselle; *Lepidozygus tapeinosoma* (Bleeker) - Fusilier damsel; *Pomacentrus caeruleus* Quoy & Gaimard - Caerulean damsel; *P. pavo* (Bloch) - Blue damsel; *P. sulfureus* Klunzinger - Sulphur damsel
- LABRIDAE** *Anampses caeruleopunctatus* Rüppell - Blue-spotted wrasse; *Coris caudimacula* (Quoy & Gaimard) - Spottail coris; *Epibulus insidiator* (Pallas) - Slingjaw wrasse; *Gomphosus caeruleus* Lacépède - Indian Ocean Bird wrasse;

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Hemigymnus fasciatus (Bloch) - Barred thicklip wrasse; *Labroides dimidiatus* (Val.) - Bluestreak cleaner wrasse; *Thalassoma hebraicum* (Lacépède) - Goldbar wrasse; *T. quinqueittatum* (Lay & Bennett) - Fivestripe wrasse; *Wetmorella nigropinnata* (Seale) - Blackspot pigmy wrasse; *Paracheilinus mccoskeri* Randall & Harmelin-Vivien - McCosker's flasher;

SCARIDAE *Bolbometopon muricatum* (Val.) - Bumphead parrotfish; *Calotomus carolinus* (Val.) - Stareye parrotfish; *Cetoscarus bicolor* (Rüppell) - Bicolour parrotfish; *Chlorurus japanensis* Bleeker - Pale bullethead parrotfish; *Hipposcarus harid* (Forsskål) - Indian Ocean longnose parrotfish; *Scarus frenatus* Lacépède - Bridled parrotfish; *S. globiceps* Val. - Violet-lined parrotfish; *S. niger* Forsskål - Swarthy parrotfish; *S. prasiognathus* Val. - Greenthroat parrotfish; *S. rubroviolaceus* Bleeker - Ember parrotfish; *S. scaber* Val. - Dusky-capped parrotfish; *S. sordidus* Forsskål - Bullethead parrotfish; *S. tricolor* Bleeker - Tricolor parrotfish

ZANCLIDAE *Zanclus cornutus* (Linnaeus) - Moorish idol

ACANTHURIDAE *Acanthurus nigricauda* Duncker & Mohr - Blackstreak surgeonfish; *A. leucosternon* (Bennett) - Powder-blue surgeonfish; *A. lineatus* (Linnaeus) - Striped surgeonfish; *A. triostegus* (Linnaeus) - Convict surgeonfish; *Ctenochaetus himotatus* Randall - Twospot bristletooth; *C. strigosus* (Bennett) - Goldring bristletooth; *Naso lituratus* (Bloch & Schneider) - Orangespine unicornfish; *Naso unicornis* (Forsskål) - Bluespine unicornfish; *Zebrasoma desjardini* (Bennett) - Desjardin's sailfin tang

SIGANIDAE *Siganus argenteus* (Quoy & Gaimard) - Forktail rabbitfish; *S. corallinus* Val. - Coral rabbitfish; *S. puellioideus* Woodland & Randall - Blackeye rabbitfish; *S. stellatus* (Forsskål) - Stellate rabbitfish; *S. sutor* (Val.) - African whitespotted rabbitfish

BALISTIDAE *Melichthys indicus* Randall & Klauswitz - Indian triggerfish; *Rhinecanthus rectangulus* (Bloch & Schneider) - Wedge picassofish; *Sufflamen chrysopterus* (Bloch & Schneider) - Halfmoon triggerfish

MONACANTHIDAE *Cantherhines pardalis* (Rüppell) - Wire-net filefish; *Oxymonacanthus longirostris* (Bloch & Schneider) - Longnose filefish; *Paraluteres prionurus* (Bleeker) - Blacksaddle mimic

OSTRACIIDAE *Ostracion meleagris* Shaw & Nodder - Spotted trunkfish

TETRADONTIDAE *Arothron meleagris* (Lacépède) - Guinea fowl puffer; *Canthigaster solandri* (Richardson) - Spotted toby

This is a rich assemblage for such a small reef. It is particularly encouraging from a conservation point of view that 9 species of chaetodonts and 13 scarids were recorded.

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